THE

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THE TELEPHONE AGREEMENT.

WE remarked last week that "until the terms of agreement are published, we cannot judge whether the price paid for the privilege (of intercommunication) is high or low." The three most important clauses of the agreement may be summarised thus:—Unless the Postmaster-General determines to purchase the company's business at the septennial period (1904) on the terms of the license (*i.e.*, by agreement or arbitration) he will buy at the termination of the license (1911) all the plant in use for the company's London system and suitable for the requirements at that date of the telephone service of the Post Office within the London area. The price to be paid for such plant is to be its fair market value at the time of the purchase, due regard being had to its condition, state of repair, its readiness for immediate working, and its suitability for the purposes required. No addition will be made to such value in respect of compulsory purchase, goodwill, or prospective profits. Any of the plant at present in use which may exist in 1911 will be purchased on the above basis, but no future plant will be considered as "suitable for the requirements of the Postmaster-General" (and therefore the subject of obligatory purchase) unless it has been brought into use with the sanction in writing of the Postmaster-General or in accordance with the specification and rules set out in the third schedule of the agreement.

An examination of the whole agreement, and particularly of the third schedule, would enable us to form a more accurate judgment on the point we reserved last week, but the above particulars suffice for the main question.

The Postmaster-General was ordered by an all-wise Parliament to institute a Telephone Exchange Service. The Telephone Company's license expires in 1911, and whatever the extent or condition of their plant at that date they might be in the position of being unable to make any use of it. The Postmaster-General had no power to compel the Telephone Company to permit his subscribers to communicate with theirs. The Telephone Company had no power to compel the Postmaster-General to purchase any portion of their plant on any terms at the end of their license. Here are two uncertainties inter-related:—(1) The Postmaster-General's Exchange might develop rapidly and render the company's plant valueless; or (2) the Postmaster-General's Exchange from the lack of communication with existing telephone users might not thrive, and the company's plant would either have to be duplicated at a prior date or purchased at the expiry of the license at an enhanced value.

The Postmaster-General and the Telephone Company have apparently proceeded to utilise these respective uncertainties as the bases of a bargain which should turn them into certainties. To any new subscriber who presents himself the Postmaster-General can offer communication with any other telephone subscriber in London. The Telephone

Company are certain of the market value of their plant at the period of their dissolution if they are sensible enough to instal only that of which the Postmaster-General approves.

The commendations bestowed upon Mr. Forbes at the expense of the Postmaster-General seem somewhat out of place. Mr. Forbes has done his duty by his colleague-shareholders, and the Postmaster-General has done his duty for the State. Let the above-mentioned terms of valuation in the agreement be compared with the following evidence from the Parliamentary Committee's Report of 1895 (Q. 5,089—5,091) :—Lord Stanley : "But in the event of the Post Office taking over the telephone (in 1911) what they would have to pay you would be, according to arbitration, the sum that you have expended in placing the telephone plant throughout the kingdom." Mr. Forbes : "I am afraid I shall not be before the arbitrators, but I think I could find out a claim for something more than that." Altering the word "kingdom" to "London," with which only the agreement deals, it will be seen that the Postmaster-General has provided for something, not more but less, than that. It may, moreover, be maintained that there is very considerable advantage in defining the terms upon which the property shall be taken over when the time comes for this acquisition to take place.

It will be seen that hitherto there has been a divergence of view as to the principle upon which an arbitrator's decision should be given. The only way of determining the license before 1911 is by agreement or arbitration in 1904. Seriously divergent views as to basis of values would be likely to prevent acquisition by agreement, and the uncertainties of arbitration where a guiding principle is lacking and the State the purchaser, would tend to prevent a resort to that method. Now the situation is cleared up as far as the London system is concerned, and the possibility of Post Office acquisition in 1904 is converted into a greater probability, and, unless our conjectures as to the results of intercommunicating calls are falsified, we believe the probability will be turned into a certainty.

It is to be regretted that the terms of agreement were not published at the same time as the new tariff and announcement of "co operative competition." If it had been so published, much of the uncertainty would have been removed, and, we believe, much adverse criticism unuttered.

The criticism which says that the new arrangement differs from the recommendations of the Parliamentary Committee of 1898 is sound. The new competition cannot be called "a real and active competition" in the ordinary interpretation of the words. And there can be no satisfying the critic who sees a public advantage in a war of spoliation between a sovereign power and a tributary vassal.

A policy of rate-cutting by the State, whose loss would, in part, be made good by the 10 per cent. tribute of its rival, would not accord with the public conscience, however much it might be approved by those who derived immediate advantage from it. The criticism which is based upon the assumption that the proposed rates of charge are too high, is a criticism which is uninformed. The complexity of telephone service, its inversion, in many important respects, of the law of wholesale and retail, cannot be grasped without study. London is the largest city in the world ; the area for communication without additional fee, we believe, the most extensive. The possibilities of growth in subscribers are great. The cost of the service must be met by the users, a deficiency to be made good by non-users is not to be considered. To lower the rates when experience shows it to be possible will be easy. To raise them if experience showed it to be necessary would be difficult. Hence we believe the Postmaster-General to be right in not making rates lower at the start.

For a small payment a subscriber can test the utility of the telephone, whilst hitherto such a test could only be made for a comparatively large sum. A "real and active" competition might under stress have made a rate lower, but the usefulness of the service might have been more than proportionately less.

We therefore regard the agreement as a sample of fair dealing between the Government and the company ; it gives probably all the public advantage that could have been obtained from a real and active competition, prevents some waste, and prepares the way for that improvement of the service which will only be complete when the authority is one.

The Crawford-Voelker Lamp.

Elsewhere in our columns we publish an article describing the new carbide of titanium lamp, which, it is said, can be made with an efficiency of 2·3 watts per candle at 100 volts, and for pressures up to 500 volts ; a few days ago we had the pleasure of visiting the laboratory where the lamp is made, and where experimental work is constantly in progress with a view to further development of the invention. A higher efficiency almost necessarily involves a higher temperature, and consequently the light produced is distinctly whiter than that of an ordinary incandescent lamp. Nevertheless, the bulb and holder of the lamp are comparatively cool, even after being in use all day. The filaments are very elastic and tough ; they can be drawn straight with the fingers, even when there are three turns in the spiral, without breaking, and they withstand rough handling. We saw a 500-volt lamp alight ; the filament in this case had three turns, but it was not necessary to support them, and the bulb remained quite cool. Lastly, a lamp which had been in use for 6,000 hours without failure showed no sign of blackening, and the globe was practically clear. We were deeply interested in this striking development ; the introduction of a high efficiency lamp will be of the greatest benefit to the electrical industry, and we look forward hopefully to further progress—more especially as we understand that the possibilities of improvement in the direction indicated are far from exhausted.

Metallic Nodules in Calcium Carbide.—Guilbert and Dinan have recently analysed some of those crystalline metallic nodules which occasionally are to be found in calcium carbide, and find them to consist mainly of iron and silicon, with small quantities of aluminium and carbon, and traces of manganese, calcium, and magnesium. A sample from the Arbine (Savoy) carbide factory gave Si, 28·60 per cent. ; and Fe, 66·30 per cent. ; one from the Giffe works gave Si, 25·95 per cent. ; and Fe, 65·26 per cent. ; one from Séchilienne gave Si, 18·60 per cent. ; and Fe, 75·29 per cent. A similar material discovered in Swedish carbide some time ago gave Si, 26·4 per cent. ; and Fe, 73·6 per cent. ; while Lewes has recorded a composition of Si, 30·76 per cent. ; and Fe, 58·06 per cent. The nodules evidently consist mainly of iron silicide ; but it is clear that they do not form one simple chemical compound, part of the constituents being merely mixed together. Lewes has found nodules of two different kinds in some of the carbide he has examined ; but Guilbert and Dinan apparently have noticed only one sort.

THE CRAWFORD-VOELKER INCANDESCENT ELECTRIC LAMP.

By F. Z. MAGUIRE.

For three years the Crawford-Voelker Laboratory has been at work endeavouring to produce a new and more economical electric lamp, utilising the rare earths. This work having been accomplished, the writer is privileged to give for the first time some account of this invention, together with some of the advantages which are likely to result therefrom.

Engineers have for some years claimed that the limitation of carbon as applied to filaments in incandescent electric lamps has been reached, and many inventors have been seeking other material out of which to produce filaments which would give a higher degree of efficiency. It seems somewhat strange that the dynamo has attained such a high state of efficiency, and that the electric incandescent lamp of commerce practically remains where it was 10 years ago. The claims of manufacturers to the production of incandescent lamps of low wattage are all discounted, and it is well known that the initial wattage of electric lamps averages, in this country, from 4 to 5 watts per candle-power, and even more. When we come to consider the electric lamp of 200 volts and over, we find still greater inefficiency, and Prof. Ayrton, F.R.S., Past-President of the Institution of Electrical Engineers, at a Board of Trade inquiry held last March, stated that 200-volt lamps were very bad, even when made by the best known manufacturers, and gave the results of some comparative tests showing the mean efficiency at starting of 7 watts per candle-power in four groups of 20 lamps each. Sir William H. Preece, K.C.B., F.R.S., &c., has also made tests of lamps of 200 volts openly purchased from four different leading concerns, and states that their mean efficiency was at starting 4·21 watts per candle-power, and at 400 hours, 5·74 watts per candle-power. The results, as shown, furnish an explanation for large electric light bills, and also for the fact that electricity is not a more vigorous competitor of gas.

The average consumer of electric light is perfectly willing to use an old blackened lamp that is giving little or no illumination, on the theory that it will do fairly well. He gives no heed to the fact that this lamp is costing twice as much money to run as a new lamp. It is also true that there are lamps on the market at the present time such that it would be better for the consumer to pay money to the salesman to take the lamps away rather than to use them; in other words, the cost of the lamp itself is but a small factor in the cost of lighting. It is the consumption of energy that costs the money.

The beauty and healthfulness and superiority of the electric lamp over gas are unquestioned, and yet people still continue to use gas with all its disadvantages, because electric light remains too expensive; hence it is with very good reason that many inventors in the electrical field have sought to improve the lamp by the utilisation of new substances which would produce higher economies.

The Crawford-Voelker incandescent electric lamp is the invention which is being brought forward at the present time with claims which are most interesting to electric supply corporations, as well as to the individual consumer. The lamp is the invention of William Lawrence Voelker, and he has been working upon it since 1897.

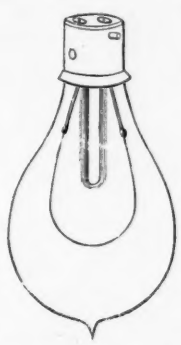
Colonel H. C. L. Holden, F.R.S., M.Inst.E.E., superintendent of the Royal Arsenal at Woolwich, who is well known for his work in connection with registering electrical measuring instruments, has made a series of tests of this lamp covering a period of 1,000 hours.

Result of Tests.

Watts per candle at start	...	2·535
,, after 500 hours	...	2·845
,, after 1,000 hours	...	3·35

Putting the tests of Sir William H. Preece with the lamps of various manufacturers against these figures, we find that the Crawford-Voelker lamp shows at the start an economy of 39·8 per cent.; after 500 hours of burning, as compared with the 400 hours of burning for the lamps used in Sir William Preece's tests, there is 50·4 per cent. economy. Sir William H. Preece discontinued his test after 400 hours, because the lamps he purchased were running so high in wattage, as to make them uneconomical for further use. The Crawford-Voelker lamps, however, continued through the 1,000 hours' test, and at the end of that time showed 41·6 per cent. economy over Sir William H. Preece's test of only 400 hours.

Mr. Thomas A. Edison, a number of years ago, was engaged upon an attempt to further improve the efficiency of the carbon filament, and stated that Prof. Marx, who was at that time the head of the Edison Illuminating Company, of Philadelphia, had told him that if a 16-c.p. incandescent lamp could be made that would run 20 to the horse-power, he could pay 10 per cent. dividend on the capitalisation of his company, and compete with gas at 75 cents (3s.) per 1,000 feet; in other words, an improvement on the maximum efficiency of the best present lamp of 33⅓ per cent. would enable the electric supply companies to compete with gas. Mr. Edison, in common with a number of others



The Crawford-Voelker Lamp.

who have attempted to improve the carbon filaments, as a matter of fact has failed up to the present time, in general practice, to get beyond 13 to 14 lamps to the horse-power. The Crawford-Voelker lamp already represents on the basis of the Holden tests, 21 to 22½ lamps per horse-power, which makes the proposition still more interesting.

The inventor of the Crawford-Voelker lamp claims to have discovered a method of effecting a chemical union between several rare metals or earths and carbon, thereby being enabled to produce for the first time a *true carbide filament*. The filaments made under the new process possess a higher specific resistance than carbon filaments, seem to disintegrate or waste away much more slowly, and are practically uniform in their resistance.

It is also interesting to note that lamps running to such high voltages as 500 volts have been successfully made by this new process, and do not seem to possess the same delicacy that the ordinary 200-volt lamp of commerce shows. These high voltage lamps are to be seen at the Crawford-Voelker Laboratory, and it may be noted that they can be snapped on and off and show less evidence of vibration than does the ordinary lamp of 200 volts.

The maximum pressure allowed under the regulations issued by the Board of Trade in this country is fixed at about 250 volts, but the difficulty hitherto experienced in obtaining efficient and economical lamps of this voltage, which would have a life long enough to satisfy the users, has practically deprived the supply companies from availing themselves of the manifest advantages of the pressure already allowable.

An interesting feature of the new lamp will be noted in the illustration, which shows that it is bifurcated at the end. The purpose of this bifurcation is to insulate the two ends of the filament. Sir William H. Preece, in March, 1885, presented to the Royal Society a paper "On a Peculiar Behaviour of Glow Lamps when raised to High Incandescence." It shows that as the voltage applied to glow lamps increased, a current flowed through the exhausted space between the heels of the filament without passing through the filament at all, simply wasting energy. This can also be readily shown by means of a laboratory experiment, which demonstrates the flowing of the current between the ends of the filament. The advantage of this bifurcation

has been demonstrated by numerous tests on the part of the inventor, and has proved that the life of the filament is greatly enhanced by the division of the globe. For high voltages it is claimed to be essential.

It would seem, therefore, that electric lighting, through this most important discovery, which has been tested very thoroughly for the past 14 months in this country and in France, is about to come into a new era of prosperity, and that the gas companies will have to look to their laurels, because for the first time electric light has reached a basis where it can compete successfully with gas. In addition to the tests of distinguished experts both here and in France in connection with the Crawford-Voelker lamp, many of these lamps have been given to consumers for test, and the testimony concerning their usefulness is a verification of the economies claimed.

In the tests made by Colonel Holden he was not content to use a constant voltage, but submitted the lamps to a street circuit, which was close to the power house, and the lamps were subjected to the fluctuations due to this close proximity. Since the date of the tests constant improvements have been going on at the Crawford-Voelker laboratory, and even greater efficiencies are shown. The laboratory has turned out over 200,000 filaments, and makes the lamp from beginning to end with the exception of the base.

In making the base, for high voltages, porcelain is used; for low voltages a division of porcelain is made in the centre for the purpose of continuing the insulation through the base of the lamp.

The results herein mentioned refer alone to the carbide of titanium. The experiments of the Crawford-Voelker laboratory already show that a number of the rare earths, other than titanium, produce just as interesting results, but have not been worked out to the same extent commercially. Combinations with no less than five different rare earths have been made, some of them giving exceptionally beautiful and interesting results, and may mean more for the future of the electric lamp than even the results herein mentioned.

In the writer's opinion the importance of this invention cannot be over-estimated. It is not within the province of this article to discuss the field open to a lamp of this nature, but it is a matter of common knowledge that any improvements in the present incandescent lamp, which will make electricity a more active competitor with gas, have a field which is practically unlimited, and will also be a great public benefit.

For the benefit of engineers desiring details of the Holden test, extracts from the report of Colonel Holden are appended hereto:—

REPORT by Col. H. C. L. HOLDEN, F.R.S., M.Inst.E.E., on CRAWFORD-VOELKER LAMPS.

In compliance with your request of December 6th, 1900, I have been since that date investigating the advantages and watching the behaviour of the Crawford-Voelker lamps. . . . I instituted a test of 50 lamps, which was started on February 27th, 1901, and continued without a break, except to allow of the lamps being measured electrically and tested photometrically, for 1,000 hours.

Eleven lamps out of the 50 broke in the first 500 hours; of these the average life would be about 350 hours. During the second 500 hours 15 lamps broke; their average life was 762 hours. The average life of the 11 and the 15 would thus be 588 hours, and if we take with these the 24 which burnt for a 1,000 hours, the *minimum* average life of the 50 lamps would be 787 hours.

The instruments used were carefully checked from time to time, and were correct to the Board of Trade standard; the continuity of the tests was assured by a recording voltmeter and also a recording ammeter being included in the circuit. The whole of the lamps tested were not only measured by me personally, but were under lock and key and also under my seal in the cellar in which they were kept under test.

The photometer used was of the Lummer-Brodhum pattern, which is as accurate and reliable an instrument as can be employed for such a purpose, and the standard of light was furnished by a Hefner-Alteneck lamp burning amyl-acetate and emitting a light equal to ·88 of what is known as the English standard candle; every care was taken by testing lamps on other photometer benches besides this one that no error crept in. The results have been corrected on the basis of the English standard candle. . . . . The efficiencies work out as follows:—At starting the Crawford-Voelker lamps had an efficiency of 2·535 watts per candle; at the end of 500 hours the Crawford-Voelker lamps had an efficiency of 2·845 watts per candle; and at the termination of the test after 1,000 hours the Crawford-Voelker lamps had an efficiency of 3·35 watts per candle. . . . .

The results of Sir Wm. Preece's test are as follows:—

The best 8-c.p. lamps (200 volts) obtainable start at an efficiency of 4·21 watts per candle, and have, after 400 hours' burning, an efficiency of 5·74 watts per candle. . . . .

The economy, therefore, shown by the Crawford-Voelker lamps over the others is thus 39·8 per cent. at starting, and after 500 hours (as against 400 hours of the other lamps) 50·4 per cent.; and even if we compare the efficiency of the Crawford-Voelker lamps after burning 1,000 hours, when it was 3·35 watts per candle, they show a superiority of 41·6 per cent., which is a very remarkable result.

I have no doubt whatever but that when these lamps have passed from the laboratory stage to that of the factory, and I see no reason why they should not be manufactured in any quantities as soon as the requisite facilities have been provided. . . . . Their already high efficiency, compared to other lamps, will be still further improved. . . . .

These remarks are specially applicable to the 200-volt lamp. . . . As regards Crawford-Voelker lamps of lower voltages—100 volts, for instance—there is no difficulty whatever in their manufacture . . . and I see no difficulty in producing Crawford-Voelker lamps of high efficiency up to 400 volts, or even more.* . . . .

LEGAL.

ATKINS & APPLEGARTH *v.* THE CASTNER-KELLNER ALKALI COMPANY.

(*Continued from page* 878.)

IN the Court of Appeal on 27th ult., the hearing was resumed of the application to strike out in the name of the plaintiffs the appeal entered in this action.

MR. APPLEGARTH, one of the plaintiffs, now appeared in person, and stating that they had not authorised the appeal and expressed a wish to have it struck out of the list.

Lord Justice WILLIAMS asked whether the plaintiffs had ceased to retain the solicitors whose names appeared on the record.

MR. APPLEGARTH said they had given them no instructions to make the appeal.

Lord Justice WILLIAMS: But so long as their names are on the record, I very much doubt whether you are in a position to make an application without bringing them here.

MR. ASTBURY, K.C., as representing the Commercial Development Company, said he appeared on the instruction of the plaintiffs' solicitors on the record to oppose the renewal of the appeal. Messrs. Atkins & Applegarth had entered into an agreement with his clients by which the plaintiffs could not withdraw their retainer without paying costs, which amounted to a large sum, and of which plaintiffs had not paid one penny.

Lord Justice WILLIAMS said that when plaintiffs had taken steps for the removal of the names of the solicitors from the record, they could make the application, but possibly before the removal could be effected the solicitors' costs would have to be paid.

MR. BOUSFIELD, K.C., for the defendants, observed that it was very difficult to ascertain what steps the plaintiffs could take.

Lord Justice ROMER said the plaintiffs appeared to have given the solicitors an irrevocable retainer to act for them, but it was not an agreement in which specific performance could be enforced.

MR. ASTBURY said it was in evidence that Atkins & Applegarth were merely trustees for their clients in the matter. He had received no notice of the application, and the moment the plaintiffs made an application that interfered with his rights he should move to restrain them.

Lord Justice WILLIAMS thought the most convenient course would be to let the matter stand over so as to give Mr. Astbury the opportunity of making such an application as he might desire to a Court of first instance.

The application was accordingly directed to stand over for a fortnight.

THE BRITISH ELECTRIC TRACTION COMPANY, LIMITED, *v.* THE COMMISSIONERS OF INLAND REVENUE.

(*Concluded from page* 878.)

IN the Court of Appeal, composed of the Master of the Rolls, Justices Stirling and Mathew, on 26th ult., judgment was delivered in the above case on the appeal of the Commissioners from a judgment of Justices Kennedy and Phillimore in the Divisional Court in November last.

In this case judgment had been entered against the Crown on a question of the stamp duty payable on a lease made by the Corporation of Croydon with the British Electric Traction Company of the electric tramways in the district of Croydon in consideration of certain annual payments reserved by the lease. When the appeal from the Commissioners was lodged before the Divisional Court, there was a dispute as to the payments on the main rent, which came to £3,000, but the appeal in respect of that matter was dropped, and a consent judgment was entered for the Crown. The indenture in question was dated January 23rd, 1900, made between the Croydon Corporation and the British Electric Traction Company under Sec. 19 of the Tramways Act, 1870. It recited that the Corporation was empowered by that Act, with the consent of the Board of Trade, to demise the right of user of the tramways referred to in the indenture, and the right of demanding or taking tolls in respect of the same. Clause 2 specified that the terms was for 21 years, and

* Since this report was written my prediction has been verified, and Crawford-Voelker 500-volt lamps are an accomplished fact.

Clause 3 gave the principal rents, as to which there was no dispute. Clause 4 provided that the company should pay, as from the date of a certificate of the Board of Trade, authorising electric traction, £100 a year per mile of road along which the tramways were laid, in lieu of maintaining roads and repairing tramways, and this amounted altogether to £900. It was also provided by other clauses that the company should purchase all electric energy required for the tramways from the Corporation at 2d. per unit during the continuance of the lease, with a provision that so long as the Corporation supplied the energy reasonably required by the company for working the tramways, the minimum sum payable in any one year should be £4,000, with provision for revision of the price charged at the end of the second year. Clause 42 provided for the determination by the company in certain contingencies of their obligation to purchase electric energy from the Corporation, and Clause 44 gave a special power of distress. On behalf of the Crown it was contended that, as regarded the £900, it ought to be charged with duty as rent, and as regards the £4,000 under the head of "bond covenant," &c., under the Stamp Act, 1891. The question for the Court was whether the instrument was chargeable with the second sums of £20 15s., 10s., and £105, and if not, with what duty it was chargeable. Mr. Justice Kennedy thought that the sums of £900 and £4,000 did not represent rent, and that the stipulations with regard to those sums were "covenants relating to the matter of the lease" within Section 77 (2) of the Stamp Act, 1891, and that therefore those sums were exempt from the payment of duty in addition to that charged on the lease. Mr. Justice Phillimore, however, thought that both sums represented rent, and ought, therefore, to be taken into consideration in assessing the *ad valorem* duty with which the instrument was chargeable as a "lease or tack." The judgment of the Court was entered in accordance with the opinion of Mr. Justice Kennedy, hence the present appeal of the Commissioners.

The Master of the Rolls, in giving judgment, held that, as to the sum of £900 under Clause 4, it was to be treated as rent, and as to such swelling the *ad valorem* duty. He construed that clause as a stipulation by the Corporation for additional rent payable by the Traction Company by reason of the Corporation undertaking to keep the demised premises in repair. He therefore accepted the contention of the Crown on that part of the case. As to the £4,000 under Clause 30, the *minimum* sum payable by the lessees for the supply of electric energy by the Corporation, his Lordship did not think that that sum could properly be described as rent. It was not, in fact, rent, but was a sum payable for electric energy to be supplied, just as gas or water was. He thought the contention of the Crown failed as to the £4,000, either as providing a claim for stamp duty as a bond or covenant or as being rent. The result, therefore, was that the Crown succeeded as to the claim for stamp duty on the £900, but failed as to the claim for stamp duty on the £4,000.

The Lords Justices concurred, and as the Crown had substantially failed on the appeal, the respondents were awarded the costs of the appeal.

District Council's Powers over Electrical Underground Wires.

(*Concluded from page* 880.)

The hearing of the actions Wigham, Richardson & Co., Limited, against the Walker-on-Tyne Urban District Council, and the District Council against Wigham, Richardson & Co., was resumed before Mr. Justice Farwell in the Chancery Division on 27th ult.

Mr. Cripps, K.C., for Messrs. Wigham, Richardson & Co., in closing his case, said that there were two points of law.

His Lordship: It seems to me it is a question of fact; namely, whether the electrical pipes are part of the vault.

Mr. Cripps said that the section relied upon by the Urban District Council set forth that any person in any urban district who, without the written consent of the authority, causes a "building" to be newly erected "over a sewer;" then, secondly, "causes any vault, arch or cellar to be newly constructed under a street," the urban authority might cause such building, vault, arch or cellar to be altered, pulled down, or otherwise dealt with. What was constructed was an arch, and that arch had now been broken through and its place filled up. On the question of fact, the point seemed to be whether the concrete foundation in which the electrical pipes are laid was part of the arch which the Council might take away. He submitted that it was no part of the arch, and the District Council had no right to interfere with or cut pipes laid in that concrete flooring.

Mr. Robson, K.C., for the District Council, said that the question was whether these pipes were in any structure, or in any part of any structure, which the Council were entitled to remove as being constructed in contravention of the statute. That was the question of fact in the case. It could not be said that the floor of a vault or arch was no part of the vault or of an arch supporting a superincumbent weight. The floor was part of the structure; and if the pipes were laid in the floor of this vault, these pipes and that floor were as much part of the structure which the District Council were entitled to remove as any other part of the structure.

His Lordship, in giving judgment, said that the view he took of this case was that it turned on a question of fact, namely, whether the pipes in question were a structure, or situated in any structure which the District Council were entitled to remove under Sec. 26 of the Public Health Act. The first action was by the local authority claiming a declaration in accordance with that section, and to that there was no defence at all, because nobody disputed that the local authority had that particular statutory right. But the company, admitting that, brought a cross action to restrain the local authority from interfering with the pipes. The company were lessees for 44 years unexpired of the land on both sides of Fisher Street. The subsoil of the street, therefore, at the *locus in quo* belonged to them. Wigham & Co., being owners on each side of the street, were minded to take their electric cables from their property on the one side to their property on the other. It happened that the local authority were themselves authorised to supply, and did supply, electric light, and Wigham & Co. got their electric supply from a rival company, and their counsel had admitted very frankly that they wanted to secure the supply to Messrs. Wigham & Co. Had Wigham & Co., being owners, simply drilled a hole through the subsoil and thrust a pipe through from one side to the other there could have been no interference by the local authority. But they had built a tunnel, with an arched roof and sides and floor of concrete. Such a structure required the written consequent of the urban authority before it was built, and as it was not so obtained, the urban authority had the right to have that structure removed. Having made that tunnel, the company changed their plans, and instead of laying their pipes in the interior of that tunnel, they cut away the centre of the concrete floor down to the clay, and laid their pipes on the clay; and on the top of them the concrete was filled in again to the height of the original flooring. The local authority wanted to cut those pipes on the ground that they were part on the floor of the arch, vault, or cellar, that they were entitled to remove the floor, and inasmuch as these pipes are in or under the floor, they were entitled to remove the pipes also. In his Lordship's judgment, the place where the pipes were now laid was no part of the floor of the vault as built. If those pipes were under the floor of concrete, the arch could be removed without touching the pipes. He was relieved from considering the question of *bonâ fides*, because it had been admitted that the Urban Council desired to remove these pipes that they themselves might get the custom of Wigham & Co. It might be for some other tribunal to say how far municipal bodies were entitled to compete with other trading bodies by using the rights given them for the purpose of protecting the public health, so as to take away the customers of their rivals in trade. He would say no more on that point at present, except that he did not think it was a reasonable use of their powers by local authorities, and he was not sorry that he was able to come to the conclusion that the pipes as placed were no part of a "vault, arch, or cellar," under the statute. The District Council succeeded in their claim for a declaration of their rights under the section, and Wigham & Co. would have to pay the costs of that action. In the cross action Wigham & Co. succeeded, and there would be an injunction to restrain the District Council from cutting, disturbing or damaging the pipes or mains, the Council to pay the costs of this action.

Judgment accordingly.

Charing Cross and Strand Electricity Supply Corporation Limited, *v.* Johnson & Hooper, Limited.

This case was in Mr. Justice Eady's list on Monday. Mr. Eve, K.C., who appeared with Mr. Becket Terrell for the plaintiffs, said the parties had come to terms. A consent order was made in the terms agreed upon, which, however, were not stated.

National Electric Wiring Company *v.* Aarons.

In the Westminster (London) County Court, on 29th ult., his Honour Deputy Judge Horton Smith, K.C., had before him the adjourned action the National Electric Wiring Company, Limited, *v.* Aarons. This was a claim for £5 8s. 6d. for work done. Mr. Heldesheimer was the barrister for the plaintiffs, and Mr. Merton solicitor for the plaintiffs. It appeared that defendants (man and wife, were sued) took a house in the Hoxton Road, Shoreditch, at the beginning of the present year. In it was an electric light installation, put there by the plaintiff company about two years before. The company had an agreement with the Shoreditch Vestry, which was the supply authority, to wire houses free, on the understanding that they received ¾d. a unit (B. of T.) for the current subsequently supplied over such installations. When Aarons took his new house and found the wiring, he wrote to the Vestry—now the borough—and intimated his wish to become a consumer. The Vestry authorities accordingly sent one of their inspectors to the premises to test the installation. He found that it was earthed in several places, and a communication was sent to the plaintiffs (whom witnesses referred to as the Free Wiring Company), requesting them to carry out the necessary repairs. The contention of the plaintiffs was, that the work they actually did was not repairs in pursuance of their agreement with the Shoreditch Vestry, but alterations in pursuance of orders given their men by the male defendant, who wanted the position of various lights altered to suit his business. John Aarons denied that any of the work done could be called "alterations." He certainly ordered none, and considered the amount claimed most unreasonable. The Wiring Company did not do 5s. worth of work, and what they *did* do was to take down some "big" (arc) lamps and put up some "little tiddy" (incandescent) ones in their place.—Mr. Cowrie, the managing director of the plaintiff company, said that when the men were putting in a new installation, or repairing an old, they did not follow instructions which might be given them by the prospective consumer, because the arrangements might be quite unsuited for the use of future tenants.

His Honour found that both "repairs" and "alterations" had been done, and that the company were obliged to do the former free

as far as the tenant was concerned, under their agreement with the Shoreditch Vestry. Defendant would, however, have to pay for the alterations. He should turn the matter over to the Registrar for him to disintegrate the amounts for the different kinds of work, and give judgment for the amount found, with the costs, at the discretion of the Registrar.

Chamberlain & Hookham, Limited, v. the Mayor, Aldermen and Burgesses of the Borough of Bradford.

(*Continued from page* 832.)

Lord Justice Williams said he felt a great difficulty in following these things, and thought if he knew the sort of question which was raised as to the alleged infringement, it would tend to elucidate matters.

Mr. Moulton said he would tell his Lordship exactly what the nature of the case was. The plaintiffs did not pretend that the theory of the brake fighting against this motor was not known—people had, as a matter of theory, enunciated it, but nobody had ever succeeded in making such a meter. The people who possibly first of all enunciated it took out a patent for it, dropped it, and probably never made any such meter. The plaintiffs were the first people who made a meter on this principle. People did not realise the practical conditions which must be observed in order to make the meter work. They did not realise that you must have an exceedingly powerful field, not only for the brake, but it was an advantage even to have a powerful field for the motor, because the obstacle to the success of all these meters was friction. You had to have a thing which would move when a single lamp was put on and which would not be really disturbed when you put 100 or 1,000 on. Now friction interfered so much in the case where there was a very small load or amount that the thing which stood between theory and practice was the realisation of how to get over friction, and the true way to get over friction was to exaggerate your forces without exaggerating your friction, so that a powerful brake and a powerful motor would work accurately because friction might be disregarded. Mr. Hookham was the first person realising that, to work it out in a practical meter, and to show people how to make a practical meter. What the plaintiffs said of the defendants was that they had taken their method of making this theory practicable, and when their Lordships came to examine the defendants' meter—which was a meter which had succeeded in doing the problem—he thought they would come to the conclusion that the defendants solved the problem by substantially using the plaintiffs' means. The defendants used powerful magnets made in exactly the same way as Hookham pointed out and claimed as necessary to make the thing practicable. The defendants said that one of the great points of difference was this: The plaintiffs measured current in their fig. 4. It was a question whether they were confined to current, but he (counsel) was putting the defendants' argument on the point. The defendants said: "Oh, your meter, on the proper construction of your specification, was a meter which only measured current; our meter measures the product of current and pressure, which means energy." The plaintiffs' reply to that was that these meters were all made for electric lighting circuits, where the one condition is that the pressure is to be constant, and that if the defendants used their meter so that the pressure was constant, what they measured was current. The real fact of the case was that the defendants' was a current meter. That was the main distinction which the defendants made between their meter and the plaintiffs'. If that defence broke down, the defendants attacked the validity of the plaintiffs' patent. That, however, was the real question with regard to infringement. A number of subsidiary points arose in the second line of defence, but the learned counsel said he would deal with those as the case went on. He thought he might say that in this case every possible defence was raised, and in those circumstances he felt compelled to read both the provisional and complete specifications, as, among other things, the defendants said there was disconformity, and that the invention claimed in the complete specification was different from that described in the provisional. The learned counsel, continuing, said that his argument must necessarily be a long one, and he did not want to sit down until their Lordships were really in possession of the whole case.

Lord Justice Romer suggested that it might shorten the case if they tried the question of infringement or non-infringement first, if that could be conveniently done. If the plaintiffs succeeded on that issue they might then have to go into the other questions.

Mr. Moulton replied that on the question of infringement it was necessary to read the specifications and claims. He would proceed to do that at once, and would not go into the other questions more than he could help.

Lord Justice Romer: The patent is out now?

Mr. Moulton: Oh, yes, my lord.

Lord Justice Williams: Then it is now a question of damages?

Mr. Moulton: Yes, my lord, that is substantially the question for me.

Lord Justice Williams: I quite understand that.

Mr. Moulton then read portions of the provisional and complete specification, and with the assistance of Mr. Astbury, explained to their Lordships the various parts of the meter on a model constructed by the plaintiffs according to the specification. The learned counsel explained to their Lordships that permanent magnets could be exactly imitated by electro-magnets. If he had a piece of iron and wrapped a coil of wire round it several times and then passed an electric current through it, it would be to all intents and purposes a permanent magnet. You could, therefore, substitute for a permanent magnet an electro-magnet. If you wanted a constant electro-magnet you put the ends of your wires on your mains, and there was a constant pressure in your mains which would drive a constant current round the magnet.

Lord Justice Romer: Is there constant pressure in the mains?

Mr. Moulton: I hope so. I do not know whether your Lordship is a sufferer?

Lord Justice Williams: You put me in a constant state of perhaps idle fear in case in a minute or two you will say this has nothing to do with this case. Will you tell me which claim in your patent you say they have infringed.

Mr. Moulton replied that he was coming to that directly. The plaintiffs sued the defendants on the first and third claims. He would soon bring the culprits in, and then their Lordships would see what he was dealing with. The infringer used an electro-magnet instead of the plaintiffs' permanent magnet; but he made his electro-magnets his moving part, and he put his current through his stationary part. That was the alternative in the plaintiffs' specification.

Mr. Cripps: We say he does not point it out, and could not do it.

Mr. Moulton said their Lordships might take that as contentious. The defendant had, as he said, the electro-magnet; but he made it his moving part, and this he put from one main to the other main. Electrically it was the same. Now the defendant took his rotating part and took the current he wanted to measure through those electro-magnets, so that he had got the whole action of the constant electro-magnets turning round with the current.

Lord Justice Williams: Mr. Cripps, you don't in any way question that what Mr. Moulton describes rightly describes what you can do?

Mr. Cripps: No.

Lord Justice Williams: Do I understand that you deny that anything in the claim covers what you do?

Mr. Cripps: Certainly. There are a good many matters in issue between us, but with respect to what my learned friend said could be done with reference to his meter they were at issue entirely.

Lord Justice Williams: You criticise what Mr. Moulton said could be done with his meter.

Mr. Cripps: Quite so.

Lord Justice Williams: But you do not criticise his description of what your meter did.

Mr. Cripps: No, I do not.

Mr. Moulton: I was not speaking of my meter but of my specification.

Lord Justice Romer: I do not think I have quite followed your third claim.

Mr. Moulton: May I come to that afterwards, because there are a number of alternatives? One of the alternatives is the one the defendants have taken.

Mr. Cripps: In the specification they talk about electro-magnets capable of saturation. In a certain sense these might be electro-magnets, but they were not electro-magnets capable of saturation.

Mr. Moulton asked to be allowed to make good his point about the converse being given as an alternative in the specification. The specification on page 4, line 50, said, "In the meter described and represented the main current passes through the armature and the shunt through the field magnet, but similar results may be obtained by reversing this arrangement, in which case the use of iron in the armature is preferable."

Lord Justice Williams: Does not the field magnet there mean permanent field magnet?

Mr. Moulton said it could not mean that. The energy going through the field magnet indicates that it must be an electro-magnet. It was quite clear in that specification that the inventor pointed out that they might make this interchange of functions. That was well known, and would not be contested.

Mr. Cripps: It will be contested. There is no claim upon it.

Mr. Moulton: No; but it is perfectly clear that they might interchange these functions. The specification went on: "In order to enable the meter to measure current the field must be constant," . . . . "and to obtain this constancy in electro-magnets they must be saturated." Learned counsel said he should like to explain what was meant by saturation. If they took an electric magnet without iron in it the magnetism was really proportionate to the current. If they put iron into it, it became very much more powerful, but for a long range the magnet was still proportionate to the current, perhaps in higher ratio, but still proportionate to the current. If soft iron were employed and the current was doubled they doubled the magnetism, but there was a point beyond which it was impossible to go. The iron would not go on increasing in power, so that if they worked with very large currents as compared to the piece of iron employed, they would find that though they doubled the current they would not double the magnetism. They had got as much magnetism into the iron as it could contain, and then they said that the iron was saturated, so that if they wanted an electro-magnet that was ever constant, even with varying degrees of currents, they took care that it was saturated because then it would not show any more magnetism. But as the specification pointed out, "In electric circuits in which the electromotive force is practically constant this degree of saturation in electro-magnets is not essential." They might have there electro-magnets instead of permanent magnets. They might have them in their field or in their armature. They must be made constant. The best way to do so is to have them saturated, but if the pressure was constant, then they need not trouble about the saturation. Well, now what the defendants did was, as the plaintiffs said, exactly

what was described in the specification. What the effect of the claim was he would deal with later. The defendants had chosen to have a constant electro-magnet in the armature, and so long as the pressure in the mains was constant, it was a constant electro-magnet in the armature. They carried the current through the main field magnets. They did not need to saturate their armature, because their current in the armature was at a constant pressure.

Lord Justice Williams: You say in your specification that in order to have this constancy of the electro-magnet it must be saturated, and then you go on to say in spite of that there is an exception, and that they are not required to be saturated. When you come to your claim, what do you say about that?

Mr. Moulton said he did not do anything to exclude it from his claim. But to go to the point which his learned friend had been trying to suggest as a distinction between his meter and that of the plaintiffs. Mr. Cripps said that his instrument, if it was put upon a non-constant supply of electricity, that was to say, an electric supply where the pressure was not constant, would not work as a current meter. But the answer to that was that the defendants took care that the meters were made and only made for putting on a constant pressure. His friend said his was an energy meter; that was to say, the armature would measure the pressure and the field magnet would measure the amount. Yes, the plaintiffs replied; but you mean to keep the pressure constant, and by doing that you really measure the current. As the defendants used it they had a constant element and a current element, and that was exactly what the plaintiffs had. It was quite true they interchanged operations, but the plaintiffs carefully told them that they might interchange operations. It was electrically equivalent, and no one had ventured to deny that.

The hearing was then adjourned.

Mr. Moulton, resuming his address on 20th ult., said that when the Court adjourned the day before he was just coming to the claims in the specification. Before reading them he wanted to put shortly what he submitted was described in the body of the specification. It was an electric meter for measuring electric current in which you had the counter-action of a motor and an electric brake. The motor has a constant, or nearly constant, field, and the current goes through its armature. There was on the same spindle the electric brake—that was the copper disc, which was also in an almost constant field, and the rotation of this measured the current that passed. That was the structural description of the invention. But Hookham pointed out that there were substitutions which could be made. What he said was: "I described the field as constant and the current going through the turning part, but you can convert that and let the current go through the stationary part and the moving part be the constant." That was put as a thing known to all electricians. The substitution could be made as a matter of course by anyone. If their Lordships went into one of the great electric lighting stations to-day with an electrician, that electrician would have to go and look at the machine and trace out the connections before he could tell whether the moving part was the field magnet or whether it was the armature, used in that sense. Whether you got the current for lighting from the stationary part or the moving part, could be only worked out by tracing the wires which led from the mains. The whole action of dynamos and motors consists of inter-action of the two parts.

Lord Justice Williams said he did not know what the word armature meant. He had seen what the learned counsel called the armature in the model handed up.

Mr. Moulton: Armature means here, and usually means, that part of a dynamo from which you get your current; originally it was the rotating part. There is really no difficulty as to the meaning of the word, but there is a great deal of confusion. The first meaning of the word was this: Your Lordship remembers horseshoe magnets—I should think that everybody has played with them when they were young—and in order to keep the magnetism of these magnets you used to put a piece of iron across the ends. That used to be called an armature. It was a piece which did not belong to the magnet but was always kept there.

Mr. Justice Williams: I know. But will you do what a cheap dictionary like Nuttall would do for me, and tell me how it comes to be used?

Mr. Moulton: Very well, my Lord. It really is that which is moved in the presence of the magnets. That was the original idea.

Lord Justice Romer: What is the derivation of it?

Mr. Moulton: It is a French word for outfit. It was applied to the piece of iron because it completes the magnet. That is the origin I have always given to it myself.

Lord Justice Williams: There were little bits like that on magnets that I used to have as a child, but I did not call them the armature.

Mr. Moulton: No, I suppose it was called the keeper. When they first had the original idea of a dynamo-electric machine it was to have a magnet with something rotating in front of it, and therefore that was called the armature. It got that name, and then it got to mean the rotating part of a dynamo machine, and that is its normal and natural meaning. You always supposed that a dynamo was made of field magnets to make the magnetic field and the rotating part was called the armature. If you go to any of the electric lighting stations you will find that all that the engines do is to rotate this rotating part in the presence of the fixed part, and that starts the currents in the wires, and these currents are collected, and those are the currents which animate the lamps, so the rotating part got to be called the armature. So we take the armature to be the rotating part in this combination. I think there was no controversy in the Court below that the armature was the part where there was the rotating power. There was a great deal of confusion, however.

Mr. Bousfield: I will admit, for the purposes of this case, that the armature is the rotating part.

Mr. Moulton: Very well. The learned counsel, continuing, said that the model before their Lordships was a complete description of the figure in the drawings. Now he would come to the infringer. He would trace the magnet current first. It was in shunt. Starting from one pole the current went through the armature, in at the top of the rotating part, and through an enormous number of coils on the armature, and came back on the other pole, so that the rotating part was a constant field magnet and was on the shunt. The consequence was that the constant part, which in the plaintiffs' case was fixed, in that of the defendants was rotating, but in both cases it was made constant by being on the shunt or by having its own by-pass. That was the sense in which both of them were constant. Then, taking the lamp current, that went to the fixed part, and through it, and made a magnetic field; and this constant magnet rotated in a varying magnetic field, varying because if the current was doubled the strength of the magnetic field would be doubled also. If you doubled the strength in the other, you doubled the strength in the armature. The interaction of these two was exactly the same as if the moving part had been stationary, and the stationary part had been moving. On the spindle of the defendants was fixed a disc which corresponded to the disc which was in the plaintiffs', and it revolved in a constant magnetic field, produced by the two permanent magnets. The defendants' had its own field, so that it differed from the plaintiffs' by having a field of its own for the disc. Both these variants, the interchange of the functions of the two parts and the having a separate field and not the same field for the brake and the armature, were alternately provided for in the specification, and any electrician would realise that you could use both the one and the other. What Hookham said was "In the meter described and represented the main current passes through the armature and the shunt through the field magnet, but similar results may be obtained by reversing this arrangement," and so on. Hookham touched the infringers by taking that alternative. He pointed out the variant that you need not have the disc in the same magnetic field as the armature; it might have its own. The words in the specification were: "The electrical brake may be formed by the armature itself so as to rotate in the same field, or it may be independent of the armature and rotate in a separate field, or a separate brake may be used in addition to an armature brake. The learned counsel said that he might observe that, although from the models of the plaintiffs' and defendants' machines they looked very different, their outward appearance was nothing to go by.

Lord Justice Williams (referring to the defendants' model): You say a slight variety in his combination?

Mr. Moulton: Yes, but a variety with an obvious equivalent. The learned counsel then referred to the claims sued upon. The first, he said, ran:—"An electricity meter for measuring currents consisting of an electro-motor with constant field arranged substantially as hereinbefore described and illustrated in the accompanying drawings, the said electro-motor being combined with an electric brake, also moving in a constant, or nearly constant, field, preferably the same field as that in which the armature rotates, substantially as herein described and illustrated in the accompanying drawings."

Lord Justice Williams said that what the patentee said there was "with constant field arranged substantially as hereinbefore described." He said nothing about reversing the arrangement as suggested at line 50 of page 4 of the specification.

Mr. Moulton: No; but that is described.

Lord Justice Williams: The subject matter of the invention is hereinbefore described as a constant field.

Mr. Moulton: Yes; but even then, if they (defendants) took an equivalent to that pointed out in the specification, I should say they would not be outside the claim.

Lord Justice Williams: I do not know. I cannot answer the question. I should have thought that they might make a combination different to the combination claimed by you.

Mr. Moulton replied that he would deal with that point. He would not forget any points to which their Lordships had called his attention. The learned counsel then read the third claim on which the plaintiffs sued:—"In electricity meters the use, for the purpose of procuring a powerful and constant magnetic field, of permanent magnets arranged as described, with very large polar surfaces closely fronting each other, so as to form a narrow slit in which the disc armature revolves, whether the same be magnetised in position or otherwise, and the means described for regulating the same, when or if necessary, substantially as herein described, and in part illustrated in the accompanying drawings."

Lord Justice Cozens-Hardy observed that it seemed that the patentee claimed a particular mode of producing a result, and that the defendants produced the same result by another form which the patentee did not claim.

Mr. Moulton: Of course, in all these matters, you have to read the claims with the specification, and construe them fairly together. When you consider that he says you can interchange it, and then goes on to tell you exactly how to do it, it is hard to believe how a man would care to explain how to get outside his patent.

Lord Justice Williams: It is hard to believe it, unless you think that the inventor had some particular reason for limiting his claim in the way he has done. Everyone has known of cases in which you described alternative means, and you found it discreet when you came to your claims to stick to one.

Mr. Moulton: I have never known of that case. I have known where you have kept to one particular claim to your

own loss. So here, after mentioning the equivalent, which he says is the equivalent by which you can obtain the same results, he goes on to give specific directions how you can carry that out. It is impossible to think that a man would assist with practical directions to get practical results in a way he was not claiming. The specification abounded with suggested useful alternatives. He thought that when their Lordships followed the whole language of the specification and the claims, it was clear that the patentee meant to include such variants as he had described. The patentee said you might use as your brake a disc, and he said you might also use a cylinder of copper. That was an example. If a cylinder of copper were used it would greatly alter the look of the machine, but every electrician would say it was an electrical equivalent.

Lord Justice Williams: Your invention does not include the statement of a new principle. You can only complain then of his taking your combination. A man has a right to take another combination.

Mr. Moulton: Yes; taking another position. No such meter had ever existed before.

Lord Justice Williams: If you succeed in that, well and good. But if you fail on that you cannot make any use of electrical equivalent.

Mr. Moulton: That no such meter had ever existed before, I do not remember being challenged.

Lord Justice Cozens-Hardy: There were electricity meters before, I suppose?

Mr. Cripps: One point was that there was nothing in our meter which had not been known and used long before.

Mr. Moulton: I never heard my learned friend raise that in the Court below.

Mr. Cripps: We said our meter was a Siemens's meter with brake attached to it, and that there was no new element in it.

Mr. Moulton said it was never pretended that it was ever used before. The only thing was a suggestion that a man tried to use the principle for eight years and then could not carry it out. Continuing, the learned counsel said his submission was that on a fair interpretation of the specification the alternatives that were specifically described, pointed out and dealt with so that they could be practically used, must be read into the first claim. In the third claim the patentee claimed this method for getting a powerful and constant magnetic field with large pole-pieces, as compared with the distance between them, for the purpose of making a permanent and strong magnet. That the plaintiffs said the defendants had taken. This was the first solution, the first successful practical meter, on this principle. The plaintiffs said that what they realised, carried out, and showed the world how to carry out, was, that you could make a strong motor and a strong brake, and that you were not to be afraid of making your motor strong, because you must make your brake strong, too. Hookham showed the world how to do that, and the consequence was that this meter succeeded. What the defendants said was that if you made a collection of everything that had been written and published on the point, and put them all together, you could get directions which would enable you to do it. His submission with regard to that was that that theory of Mosaic had always been objected to by the Courts. A question of novelty was a question of fact, and it was not the question whether the world might have known, but whether it did. The evidence was the test. The test was, did anybody ever know how to make a meter of this kind before, and were the plaintiffs the first to teach the world how to do it?

Lord Justice Williams: When you say the real question is whether anybody ever did make a meter of this kind before, I should like to point out that they made electric meters before. You must get beyond that.

Mr. Moulton: I mean an electric meter formed by an electric motor acting against an electric magnetic brake. I say the world had never seen one before.

Lord Justice Romer: It has been pointed out that you could make electric meters for measuring purposes with an electric motor acting against an electric brake, but there had been a difficulty in doing it owing to the friction, and what you did was to adopt a form of the principle which obviated that difficulty, so that your claim would really be for the form by which you carry that into operation.

Mr. Moulton: Yes; but I think, when you come to see the alleged anticipations, our merits are very much more than that. We say, therefore, although people had seen the possibility of doing it, nobody had shown the public how it could be done at all. We say that essential for success we have put into our specification, and that that is what the defendants have taken. That is the best way to put it.

Lord Justice Williams: You have told us that for eight years some person tried to produce such a meter but failed; that the difficulty he could not get over was the difficulty your clients did get over. What difficulty was that?

Mr. Moulton replied that the supposed difficulty was getting over friction, but his belief was that what stopped them was that they did not know how to make powerful and permanent magnets. The plaintiffs showed the world the ways of getting over friction, besides how to make powerful and permanent magnets.

Lord Justice Williams: I want to know what you say was your invention which enabled the using of powerful and permanent magnets, because powerful and permanent magnets were not novel

Mr. Moulton: We say they were. We say the knowledge of the world before with regard to magnets was this, viz., that you could magnetise a thing powerfully, but that it rapidly would lose its magnetism. If you magnetised to the full extent a piece of steel, a tap with a hammer would make two-thirds of it go. The learned counsel then referred to the evidence of Mr. Dugald Clerk in the Court below, and said that Mr. Clerk was asked what the defendants' meter measured at Bradford, and he said current. It was put on an electric lighting circuit, which had to have constant pressure, and he (counsel) was satisfied to rest with that. It was objected that this might be put on mains where the pressure varied very much, and then it would measure the product of the pressure into the current. It would not measure the current, but the product of the two. The plaintiffs' answer was double. They said it was used for electric lighting mains where the pressure was kept constant, and that the defendants showed themselves that it was never meant to be used for varying potential, but was meant to be used on a constant source. The plaintiffs said the defendants used the meter as they described it to be used, as a current meter. What the defendants replied was that theirs was an energy meter, and that if you were to put it on a non-constant circuit, it would measure energy. Very likely; but it did not measure energy, it measured current.

Lord Justice Williams: Do you agree with Mr. Justice Farwell who, having described the defendants' meter as an energy meter, says it will not directly measure current at all?

Mr. Moulton: No, unless it is on a source where the pressure is constant—where one element is constant.

After the luncheon adjournment, reference was made to the application which had some time previously been made for leave to file further evidence on the appeal. Mr. Moulton said it had then been agreed between the parties that Mr. Swinburne, as the plaintiffs' expert, and Prof. Ayrton as the defendants' expert, should re-measure magnets put in evidence, and as to which, at the time, there was some controversy. Those gentlemen had since met, and he had a report.

Mr. Bousfield said he had no report from Mr. Swinburne.

Mr. Moulton said this was what happened. In his report Mr. Swinburne said that he and Prof. Ayrton measured the electromagnet, but in the condition into which it had been put at the trial. Then Mr. Swinburne suggested that it should be measured in the condition in which it was originally, but Prof. Ayrton absolutely refused to do so, because he said he had never made a statement about that magnet, and that he had never suggested that the magnet, as it existed before, could be used for braking purposes.

Mr. Bousfield objected to the reading of the report.

Lord Justice Williams did not think time would be saved by constant interruptions.

Mr. Bousfield said he objected to his learned friend going into matters not in evidence before the Court.

Mr. Moulton: What happened was this; I have got the report ——

Mr. Bousfield: Now, I object to that. My friend proposes to read a statement not given to us, and which is not in evidence.

Mr. Moulton said that all Mr. Swinburne did was to give an accurate account of what passed when the meter was tested.

Lord Justice Williams asked Mr. Bousfield if he suggested that the results of the tests by the one expert and the other ought not to be brought before the Court?

Mr. Bousfield: Yes, I do; my friends are departing from what was agreed.

Mr. Moulton: The Court directed that two magnets should be tested, and what happened was this: One magnet—the magnet which was altered at the trial—was tested, and when Mr. Swinburne suggested the removal of the iron pole-pieces so as to make the magnet conform to the magnet as it was originally, and then test it, Prof. Ayrton refused to do so, as he said he had never made any statement as to its braking power.

Mr. Bousfield said if this report was admitted he hoped their Lordships would allow Mr. Swinburne to go into the box so that he might cross-examine him if necessary, and also allow Prof. Ayrton to be called. As he and his learned friend were not agreed, it was necessary to make the matter controversial.

Mr. James Swinburne was then called and put in his report, from which it appeared that with the disc revolving in a space of $\frac{1}{16}$th of an inch with 100 volts at 10 amperes, the rate of rotation was 10 times in 48 seconds. A second experiment at 99½ volts at 10 amperes took 48½ seconds. Witness then said that he asked Prof. Ayrton to remove the iron pole-pieces for the purpose of a further test, but Prof. Ayrton said it was useless to do so, as he had made no reference to the braking power of the defendants' machine which had not the iron pole-pieces.

Mr. Moulton: Then all that was done was done with the iron pieces which were an addition made before the trial, and Prof. Ayrton refused to have the meter tried without them, because he said he had never made any statement with regard to it. Is that an accurate account of what passed?—Yes.

Cross-examined by Mr. Bousfield: Prof. Ayrton's evidence at the trial was given with reference to experiments with this magnet with these pole-pieces attached?—That is not for me to say, but you may perhaps take it so.

And those experiments were repeated?—Yes.

And they confirmed the evidence which Prof. Ayrton had given?—That is so.

You expected to find that Prof. Ayrton had made some mistakes in his figures upon the information given to you?—Yes, I did.

And you were disappointed?—No, not disappointed. There was no mistake.

Now, then, with regard to these pole-pieces?

Mr. Moulton: We only want to get that the magnet without the pole-pieces would not have the braking force suggested.

Mr. Bousfield: I think it is essential to put a question.

Lord Justice Williams: I don't understand what you want to ask. Do you wish to show that Prof. Ayrton did not say so?

Mr. Bousfield: No.

Lord Justice Williams: Then we may take it that Prof. Ayrton did say so.

Mr. Bousfield: I have a very great object in putting the ques-

tion. It is said now by my learned friend that some other experiment ought to have been tried and permitted—an experiment in which the magnet was tried with the pole-pieces. I wish to show why that would not have been a legitimate experiment to try. It is not usual to allow a controversial statement to be put in without counsel on the other side being allowed to cross-examine.

Lord Justice Williams: But when I asked you if the statement was accurate, you said it was.

Mr. Bousfield: Then I ought not to have admitted anything of the kind, because it is the first time I have heard of it, and I have not the slightest idea as to what Prof. Ayrton will say about it. But I assume it is as Mr. Swinburne says.

Lord Justice Romer: I should like to understand where we are. As I understand, Mr. Swinburne was only put into the box to verify the result of the experiments.

Mr. Moulton: That is all.

Lord Justice Romer: And you have no further evidence in the case.

Mr. Moulton: No.

Lord Justice Romer: Then all the witness says is that he made the tests, and that they were substantially in accordance with what Prof. Ayrton had said with reference to the magnet at the trial. It seems to me, Mr. Moulton, that you want to get in something else, something which was not assented to.

Mr. Moulton: No. It is just the opposite. There were two meters to be tested, the one as it was originally and the altered one, but with reference to the former Prof. Ayrton said it was useless to make the tests, as he had never said it had braking power.

Lord Justice Romer (to witness): Did you test the unaltered exhibit?—No. It was not there, but I would have taken for the purposes of my experiments the altered one with the pole-pieces off, as it would have made it uniform with the other.

Lord Justice Romer: Where was the other exhibit?—I do not know.

Mr. Moulton: It was the defendants' exhibit.

Mr. Bousfield said the exhibit belonged to Prof. Ayrton, and as the exhibit marked had disappeared, he was unable to identify the particular instrument among the others which he had.

Mr. Moulton observed that he was satisfied that the learned judge in the Court below thought that the Ayrton magnet in the old state was as powerful as Hookham's.

Lord Justice Williams said there was so much that was remarkable about the non-production of an exhibit of this sort that he felt they would have to have a personal statement from Prof. Ayrton.

Mr. Bousfield said that Prof. Ayrton had been ill or he would have been present. He agreed that they must have Prof. Ayrton present. If the missing exhibit was in existence and it could be identified his learned friend should have it.

The Witness was then further examined by Mr. Bousfield, and said that even 20 years ago a man, if he wanted a braking effect, would bring his magnet as close to the disc as possible.

Re-examined by Mr. Moulton, he said that before this case he did not know of any magnet which had the addition of pole-pieces. A magnet without the pole-pieces would have a very poor braking power.

Have you found anything published with regard to Ayrton and Perry's ammeter which would show persons how to put on the pole-pieces?—No.

And in your opinion did Mr. Hookham first teach the world how to make these satisfactory brake magnets?

Lord Justice Romer: That is the question we have to try.

Mr. Moulton: Well, I am quite satisfied with my evidence.

Lord Justice Williams asked Mr. Moulton if he could tell the Court what propositions he hoped to establish.

Mr. Moulton: I propose to prove that with regard to Claim 1, the defendants' meter has all the points there mentioned, or that they have taken what is stated as an equivalent form. Then with regard to Claim 3, I propose to prove that that was not known, and that the absence of the knowledge there referred to was the obstacle to success in these meters.

Learned counsel was proceeding to state what he was, by the evidence, proposing to prove as to infringement, when the Court adjourned.

Mr. Moulton, on 21st ult., continued reading the expert evidence given in the Court below, during the course of which Mr. Cripps observed that the defendants had never set up the Ferranti meter or the Edison meter as anticipations.

Lord Justice Romer: I understand that what is said is this: The plaintiffs say that, on this principle, there had been no meter in actual use—the principle of the motor and the principle of the brake was known, and that the patent could only be a patent for the application of the principle, and the defendants said they had got a meter different in application, although on the same principle.

Mr. Cripps: Yes; and that none of the combination claimed in Claim 1 is taken by us.

Mr. Moulton: I join issue in this way: We were the first persons who succeeded in doing it, and the first persons who described it and to give sufficient directions to enable that to be done. I say that makes our invention patentable. With regard to the infringement, which is the great point in the case, I say they have taken in their combination exactly what we claim in our first claim, and that the defendants succeeded in the very way we had succeeded in.

Lord Justice Romer said that if the defendants adopted a substantially different method of carrying out the principle, there was no infringement, and if they did carry it out on the plaintiffs' method, then there was infringement.

Lord Justice Williams observed that you could not patent a principle, as such, at all.

Mr. Moulton: No.

Lord Justice Williams: Having started with that, the consequence is, that when you speak of patenting a principle, you are always speaking of patenting a method, a concrete method of carrying it out; but, having got so far, I am not quite sure that I agree as to what are the limits of protection to an inventor who has thus patented a method of carrying out a principle.

Mr. Moulton replied that he thought the real difference was as to the meaning that you applied to the word "principle." You could not possibly, say, patent the elastic force of steam. People used it, but they could not say they would patent it. But the word "principle" must be used in a limited sense. The plaintiffs said that they had shown the world how to solve the problem and make such a meter. Nobody denied that the plaintiffs had shown the world how to make such a meter. The defendants said that they had the right to use that idea, but the plaintiffs said they had got success by taking plaintiffs' road to success and their prescribed means, and, therefore, it was an infringement. The plaintiffs said that the defendants had succeeded through taking their methods.

Mr. Cripps: Our case with regard to what we do is that both the principle and the application were prior to the plaintiffs' invention.

Mr. Moulton observed that the defendants described their meter as an energy meter and the plaintiffs as a current meter, but what the brake measured must be that which it balanced, and that was the energy of the motor. As the only important thing was to measure the current, the plaintiffs took care that the magnet was constant. The defendants had a contrivance in which they did not take special precautions to make the magnet constant, but they put it under circumstances in which it was in fact constant. Bradford, having a well-conducted Corporation, kept its mains at a proper pressure, and they calculated upon that and put something upon their instrument which would spoil its work if it were not going to be used in circumstances in which it would be constant. Both meters were energy meters, where the current was constant, and both were so used that they measured current. The plaintiffs for the first time used magnets with large polar surfaces close together and used them for braking, and the defendants were doing substantially the same thing. What the plaintiffs said was that the defendants in ploughing with their heifer had found out their riddle.

Mr. Moulton then continued the reading of the expert evidence given before Mr. Justice Farwell at great length. He said that the defendants did not allege previous user as invalidating the plaintiffs' patent, but referred to a long chain of publications as showing previous knowledge of the methods claimed, and on that point a great deal of evidence was gone into before Mr. Justice Farwell. He thought their Lordships would, after hearing the evidence and the publications read, come to the conclusion that all that was disclosed consisted of theoretical prophecies and paternal advice without any attempt to construct upon those bases a practical meter prior to the plaintiffs' patent. The defendants had looked about at all the machines that were made for all kinds of purposes, and when they saw a thing which in its form would suit the plaintiffs' meter they said it was an anticipation. He (counsel) remembered the late Sir George Jessel (M.R.) saying that you might have a patent of selection; that of all the milliard forms in which a thing might be, if you selected one which would answer your purpose, and you claimed it for that purpose, it might be that there was real invention in that.

Continuing, the learned counsel said that the plaintiffs claimed to have taught the world how to make a magnet which would without ageing remain permanent.

The learned counsel had not concluded reading the evidence when the Court adjourned.

Mr. Moulton, on 22nd ult., continued the reading of Mr. Swinburne's cross-examination in the Court below, and dealt with one of the alleged anticipations relied upon by the defendants, viz, Siemens's specification (No. 1,919 of 1872). In that specification said the learned counsel, nothing was said about constancy and power of the magnet, all it said was that it would be dead to the surface. A closed magnet had no influence on what was outside.

Lord Justice Williams: In Siemens's provisional specification there was a statement that a magnet in this shape would have little or no effect upon external objects.

Mr. Moulton: No

Lord Justice Williams: Mr. Cripps suggests that such a statement involves necessarily a further statement that such a magnet is in a state of constancy, and that if that conclusion is right, it must not be based upon the hypothesis that where a magnet is operating upon external objects, it is losing some of its force?

Mr. Moulton: Now, that is absolutely inaccurate.

Mr. Cripps: That is not how we put it.

Lord Justice Williams: I am sorry to say that I know quite well that it is impossible for me to express a proposition in scientific language, because I am not a scientist, but substantially I thought I had sufficiently explained what was maintained here in unscientific language.

Mr. Bousfield said that the proposition on behalf of defendants was that it was well known that to get constancy of the magnet you had as nearly as possible to keep the magnetic circuit completed, and that Siemens said that in order to have the magnetic circuit completed, you must have magnets with large polar surfaces.

Mr. Moulton remarked that in Siemens's specification there was

no suggestion of constancy. After reading a great amount of evidence, he read the judgment of Mr. Justice Farwell in the Court below, and in reply to a question from Lord Justice Vaughan-Williams, agreed that the claim was for a combination, adding that the fact that Hookham's was not the first instrument for measuring electricity, did not alter the merit of the invention, inasmuch as the plaintiffs did not obtain a known result by practically the same means as those that had been employed before.

At the conclusion of the reading of the judgment, Lord Justice WILLIAMS said the grounds on which the learned judge had decided against Claim 1 in the plaintiffs' specification were necessary fatal to Claim 3, and that the grounds on which he decided against Claim 3 were necessarily fatal to Claim 1.

Mr. MOULTON said that if the plaintiffs could succeed on Claim 3, they succeeded on Claim 1, too. He thought that when their Lordships came to consider the question, aye or no, was it necessary for success to have strong and permanent magnets, they would decide that it was necessary for success. The defendants had not produced any meter which would work without a strong and permanent magnet. He (counsel) could not believe that a thing like this could have been known, and not have left a trace in the whole of the literature of the time. It was, of course, very nice for rival inventors to say: "Oh, we knew all that all the time and what was stopping our succeeding." That was not the way to prove it. He submitted that nobody before the date of the plaintiffs' specification believed that you could at once have constancy and power—magnets strong enough to be practicable, and magnets that month after month and year after year would not decay. It was Mr. Hookham who had found the way to have absolutely constant magnets, which were so powerful as to make the braking action which broke all the speeds of this meter into practical limits, and that it was which solved the problem. What the defendants had to show was that more or less people knew the problem, and there was not a single thing in the literature on which the defendants relied which told the world that for success you must have power and for success you must have constancy. He (counsel) did not say that the people wanted to be told they wanted constancy, but he did say they wanted to be told they wanted power. Mr. Hookham said that constancy and power must be united for success, and they did not find anybody else showing that. He submitted that in this case there was really *de facto* novelty in Claim 3 of the plaintiffs' specification, and that if that was so Claim 1 was good.

At this stage the learned counsel said he would leave it to his learned friend Mr. Astbury to finish the argument and the reading of evidence.

Mr. ASTBURY, in opening his remarks, said that his learned friend was good enough to say, when he finished his address, that they had agreed to divide the work. He hoped their Lordships would not imagine from that that he was going to attempt to occupy their Lordships' time at the great length that his learned friend necessarily did. He was not himself in the case in the Court below, and he had had to try to gather it from the report and the specifications. It seemed to him that the first problem their Lordships had to solve was to find some reason how it was that Mr. Justice Farwell came to the conclusion he did generally, because substantially he found every question of fact against the plaintiffs, and, he thought, nearly every question of law that could bear upon the points he had to decide. There were before him as witnesses Mr. Hookham on the one side and Mr. de Ferranti, a rival inventor, on the other. For the present purpose he wanted to say this, that those two gentlemen were put one against the other, but he had Mr. Dugald Clerk and Mr. Swinburne, who gave evidence for the plaintiffs, and Profs. Ayrton and Ewing, who gave evidence for the defendants. Of course, it was not a matter of the judge having seen the witnesses and credited the one against the other. That was absent, of course, in this case. But it was a curious problem how it was that Mr. Justice Farwell undoubtedly accepted the evidence of Profs. Ayrton and Ewing, and entirely disregarded the evidence of Mr. Clerk and Mr. Swinburne. Their Lordships knew that Mr. Swinburne and Mr. Clerk, whatever else they were, were very careful and accurate witnesses. Whether they appeared for one side or the other they gave their evidence, he thought, as was well known, with very great care. Certain theories had been stated by Profs. Ewing and Ayrton as facts, which he had tried to classify, and the learned judge had accepted them as such. The most important of them were not put to plaintiffs' witnesses in cross-examination. There were certain statements of fact made by both those witnesses which could be shown to their Lordships by way of argument to be hopelessly wrong. It might be demonstrated by the articles themselves. There were certain of these matters of fact which their Lordships could see for themselves. He could show, without any contest at all, by taking the actual articles themselves, what they would do on a disc—he could prove that Profs. Ayrton and Ewing were 1,000 per cent. out in their remarks. If you got a question of a meter, in which you have 1 or 2 per cent. out either in the motor or the brake, as regarded the law, which they must both follow, the thing was hopeless; but if they could show that they were 1,000 per cent. out, then their Lordships would be in a position that Mr. Justice Farwell was not in. He took their evidence as a whole, and accepted it as a whole *en bloc*. If it turned out that that portion of it which could be tested without further evidence was so hopelessly wrong, as he submitted to their Lordships it was, then it was a very, very great reason for holding that there might be ground for similarly doubting a great deal of the rest of their evidence. For instance, let him give their Lordships one curious answer of Prof. Ewing. That gentleman said that if he had had an assistant who could not make the plaintiffs' meter from Marcel Deprez's paper or Uppenborn's paper—he forgot which it was, but either would be sufficient for him—he would have dismissed him as incompetent. Now, Sir William Siemens, who, he supposed, was one of the greatest electricians of his day, made what was called the Siemens energy meter. After his death his brother, Dr. Werner Siemens, worked upon that meter with the knowledge of Deprez and Uppenborn, but could not make it, so that really what Prof. Ewing had said would amount to this, that Dr. Siemens was not fit to be an assistant in an electrician's laboratory. But the whole thing was so monstrous as evidence that their Lordships would have to judge when they read that evidence against the evidence of Mr. Clerk and Mr. Swinburne, which ought to be accepted. Continuing, the learned counsel said their Lordships would find that Claim 3 was this: In a new electricity meter the use of permanent magnets, powerful and constant for a certain purpose, magnets powerful and constant, as shown in the specification. Let them just mark what that meant. There was not a word about permanent or constant magnets made in that way in the provisional specification, and it was suggested in the Court below that the plaintiffs' patent was bad for disconformity, because the plaintiffs' invention in Claim 3 was for a magnet which was not claimed in the specification. But it was nothing of the kind. The provisional foreshadowed that the plaintiffs' invention, *qua* the part that was relevant here, implied a large, constant and powerful force. It was perfectly competent for a man in his provisional, and before he put in his complete specification, to state any way, or the best way, he knew for obtaining that power and constant force that he referred to as one of his elements of combination in his provisional specification. There was no claim at all in claim 3 for magnets *per se*. The only claim in the third claim was for the use of magnets made powerful and constant in a certain way—in an electricity meter for the purpose he had described in his specification. If he was right upon that, it did not matter a bit whether they were new or old. If he was wrong about that, then the patent was bad for disconformity. If Claim 3 meant that the plaintiffs claimed magnets *per se*, their provisional specification was not a claim for a magnet or anything like it. But it was a claim for the combination of parts and elements in a meter. If that was so, it would appear that a very very large amount of this evidence was irrelevant. It supplied the clue which the plaintiffs were entitled to use, as to whether or not Profs. Ewing and Ayrton were really reliable as witnesses upon this particular class of work. Prof. Ayrton was a disappointed attempted inventor in this matter. He had tried to invent this meter. He had hopelessly failed, and after years of failure, and when it was not worth his while to pay the fees on his patent—it was after these years of failure that he came and asked the judge to believe that he disclosed in that specification of his sufficient to anticipate part, at all events, of the plaintiffs' invention, and the learned judged believed him and accepted that evidence. Far be it from him to suggest that Prof. Ayrton was not the most truthful, upright man in every possible way. It was not a matter of that kind at all. It was a matter where he allowed himself to be led away by theory and stated theories as facts, which the plaintiffs could prove to be wholly wrong. Now the first problem he (counsel) wanted their Lordships to consider was what really was the problem in 1877 that the plaintiffs said this invention solved. It was very easy now that things had been seen, papers raked up having some bearing upon this motor and brake, to say that the problem was simply to make a motor and a brake interact according to a proper law. That was one of the problems, but it was not *the* problem. *The* problem was to make a commercial instrument that would measure Board of Trade units. That was not a scientific instrument, and it was in that direction he (counsel) thought that the learned judge had gone wrong. They were dealing with a commercial apparatus used commercially and for commercial purposes only. What was the purpose for which it had to be used? Under the Electric Lighting Acts what the customer had to pay for were Board of Trade units. All that talk about current and energy was very, very wide of the mark, because what you had to tell on your meter was Board of Trade units, and those only, and the plaintiffs' meter on its clock-face showed Board of Trade units, and so did the defendants'. Now, what was an energy meter, which Mr. Cripps was so fond of referring to? An energy meter was a meter which you wanted to put on exactly the same circuit, because the whole difference and the whole mistake, if he might so call it, with respect to that which Mr. Justice Farwell had made, was in thinking that an energy meter was the same thing as an energy measurer. As a matter of fact, it was nothing of the kind. The learned Judge talked in his judgment about constancy as one of the factors which was destructive of an energy meter, but it was nothing of the sort; it was destructive of an energy measurer. If, in other words, you wanted to go to a circuit and found out on that circuit at a particular moment what the variation of potential was, you used an instrument called a voltmeter. That was a thing that you put on for a moment or so many minutes, and it would tell you at the time you had got it in operation what the pressure was that was going through at that time. It added nothing up at all. That was all it told you. For that purpose it was abundantly clear. It was obvious to everybody that if you had one of your forces constant, that was one of the two forces that produced rotation—there were two fields, the armature field and the magnetic field—the way in which the rotation was got was by the inter-action of those two lines of force which went in opposite directions and produced a torque, making the thing go round. That field was only produced by current and not by pressure. The voltage had no effect upon the field. The only way by which the magnetic field was produced was by the flow of current along a wire or in a magnet, so that in one of those inter-acting parts you had current flowing, and in the other inter-acting parts you had what was called a shunt current passing. It was quite obvious that if one of those parts was functionally constant,

that was to say, constant because the machine made it a constant factor, whatever the current that went through it you would get one variant multiplied by one constant. That could only give you current because energy was the multiplication of current by pressure. If you wanted to get at that, this being on the assumption that you wanted to measure variation of energy, and these being variants, you must have both interacting parts of your machine —parts which would interact—as two variants, and not one as a constant and one as a variant. That was an energy measurer. "Now, then," said his learned friend, "our meter is just the same; if you put our meter on a circuit, a constant field is destructive." If their Lordships would excuse him (Mr. Astbury) putting it in that way, it was dreadful nonsense.

Mr. Cripps: Your witnesses said so.

Mr. Astbury: They did not. My learned friend told the learned judge that our witnesses had put it on these things, and the learned judge accepted it from him. But they did not put it on these things. I am going to give you chapter and verse for every word I say as regards any matter of contest. But what our witnesses said was, with an energy measurer—that is, a thing which measures variation—a constant field in the instrument itself is destructive, but they denied that it was so in the meter, and it is perfectly obvious that it is so. I have been speaking about energy measurers, but I am told that I should have referred to them as energy indicators. What do the defendants put this meter on a circuit for? It is perfectly obvious they put it on a circuit to tell them how many Board of Trade units have been consumed, just as we do. Continuing, counsel said that what Mr. Hookham did was this: He invented a means by which you could overcome the three different kinds of friction which were found existing in all these meters, so that he could so standardise his meter that one lamp would only just turn it round at all. The magnetic brake was not really relevant to that. You took the brake out altogether for a minute, and you could so standardise your meter, if you got rid of friction, that with an infinitesimal amount of current the thing would turn. Your brake was only to prevent it running almost to infinity as soon as you got more current passing through. Your object was simply to keep it slow and keep it proportionately slow.

Lord Justice Romer: You say that there was something besides the commutator and the electric brake and the motor itself—something besides those three.

Mr. Astbury: The commutator is one very important way of eliminating friction. There are two things.

Lord Justice Romer: Where do you point those out as important to be got over in your specification?

Mr. Astbury: I will divide my invention into five.

Lord Justice Romer: No, you say there is a combination of those five things, and if they were essential you ought to have called special attention to it in your specification.

Mr. Astbury: We have actually claimed it in one of the claims. The learned counsel then referred their Lordships to Claim 8: "The arrangement and combination of parts hereinbefore described and illustrated in the accompanying drawing for diminishing the friction of the rotating axis." It might sound very small now, but you had to get rid of axial friction, commutator friction, and residual friction. Those were three kinds of friction that Hookham showed the way to get over, and the defendants had taken every single one of them.

Lord Justice Williams: I assume, after what you have said, that Mr. Hookham's electricity meter would work properly with a single lamp, or with a number of lamps; but does Mr. Hookham, in his specification, point out that that is one of the advantages secured?

Mr. Astbury: No; he simply invents it as a commercial instrument, and your Lordship knows you never, in a specification, tell anybody what your specification will do. As long as you invent a way of making a thing, and you invent a compact commercial meter, and give directions how to make it, you are entitled to the benefit of anything that flows from making it in that way, although that is not mentioned or referred to in the specification. You need not even give the quantum, the essentials of any part, nor need you give the operation or results of your invention at all. As long as you know any invention is a meter for metering light, every result that you get from making it in accordance with the directions contained, I submit you get, and clearly get, without any suggestion or reference to the specification, and I think some judges have suggested it is a very dangerous thing for inventors to give their objects, because very often it turns out that the invention will in one year be applicable to something that was unknown a year or two afterwards, and if you had limited yourself to pointing out your advantages, it might be a difficulty in the patentee's way.

At this stage the further hearing was adjourned.

(To be continued.)

[The hearing of this case was concluded on November 29th, when their Lordships reserved judgment. Lord Justice Vaughan-Williams said that their Lordships would consider whether they would desire to hear any further argument upon the other points on which the defendants' counsel had not yet been heard.]

ELECTRICAL MATTERS AT THE LONDON COUNTY COUNCIL.

The Telephone Service.—The report on the Post Office telephone system, the debate upon which was adjourned at the previous meeting, was again brought forward by the Highways Committee at Tuesday's Council meeting. It was recommended that a copy of the report should be forwarded to the Postmaster-General, with an expression of regret that the Post Office scheme does not establish real and effective competition as recommended by the Select Committee of 1898, and does not secure to the public the advantages which it had been led to expect.

Mr. Cornwall, as a rider to the recommendations, proposed that the Postmaster-General should be asked to receive a deputation from the Council on the subject, in order to lay before him reasons why he should not ratify any agreement which would prevent an early reconsideration and reduction of the charges now proposed by the Post Office. In doing so, he remarked that as it stood the recommendation was hardly sufficiently strong, and that merely to pass the Committee's proposal would not convey to the Post Office or the public a fair indication of the views of the County Council and of London on the subject. The Council had no official knowledge of the agreement, but they could at least ask the Postmaster-General not to tie his hands, and the people of London were entitled to know what agreements were being made between the two parties.

Earl Russell, who seconded the addition to the recommendation, observed that there was little to say after the speech of the chairman of the Committee in the previous week. He was glad that Mr. Cornwall had discovered a further step which might be taken. The metropolis was entitled for an expenditure of £2,000,000 to a commercial telephone at rates which would pay interest on the capital, but they found from the list of charges that it was nothing of the kind. To speak plainly, the Council had been sold by the Post Office.

Mr. Robinson stated that the whole question was a departmental one with the Post Office. After an expenditure of £1,350,000, he regretted that the result had not been the production of a cheaper telephone service. The speaker then stated that a telegram had been received from Lord Londonderry announcing his willingness to receive a deputation from the Council on Friday, and if the amended resolution was carried, he hoped the clerk would be authorised to communicate with the Postmaster-General on the subject.

Mr. Beachcroft, who followed Mr. Parker, remarked that disappointment was general throughout London at the terms proposed by the Post Office. The net result was that there was no real competition and no likelihood of obtaining a reduction in the charges of the Post Office which was already severely hit by the telegraph service, and no doubt the Post Office desired to wipe out some of the losses in the past. If the company were to be granted the use of the Post Office underground wires, there was no doubt the rights of the Council, which had co-operated with the Postmaster-General in opposing the action of the company in regard to underground wires, had been bartered away. He was of opinion that the County Council had not used its best endeavours to work with the Government of the day and the departments of State.

Mr. Dickinson referred to the action of the company at Tunbridge Wells, where the annual charge, in consequence of municipal competition, had been cut down to £4, as against £5 17s. 6d. by the Corporation. It was only possible for the company to act in that matter in the provinces, because it obtained £100,000 in London, and tried to ruin municipal enterprise in other towns.

Capt. Sankey contended that the scheme of the Post Office was the best possible for London. It was not a final project, but was capable of revision. He then compared the charges in other countries with those of the Post Office, and submitted that the latter were equally as cheap. The prospectus of the company was before the public, and the contracts were open to inspection at its office; there was no secrecy, and he had personally been to see them. He was of opinion that the Post Office had made the best agreement which was possible with the company.

The Rev. Fleming Williams and Mr. McKinnon Wood having addressed the Council,

Mr. Henry Clarke, as a City member, stated that he had heard nothing in the City but lamentation at the result of the long conference between the various parties concerned in the question, and he expressed the hope that the County Council and the City Corporation would be able to obtain some remedy.

Mr. J. W. Benn, in the course of a brief reply to the discussion, admitted that the City had taken the matter up in earnest, and had decided to hold a conference to consider the question. He would be happy to represent the Council at the conference, and the Committee would accept the rider proposed by Mr. Cornwall.

The recommendation, as amplified by the addition, was then put to the meeting, and was unanimously adopted.

Electric Tramway Extension.—The report of the Highways Committee reminded the meeting of the authority given last May to prepare specifications and invite tenders for the reconstruction of those portions of the Council's tramways between (1) the junction of Kennington Road with Westminster Bridge Road and St. George's Circus; (2) the Elephant and Castle, along Old and New Kent Roads, New Cross Road and Greenwich Road, and the terminus at Trafalgar Road, Greenwich; (3) the Elephant and Castle *vid* Newington Causeway and Dover Street to the junction of New and Old Kent Roads. The Committee stated that there were three other tramways, the reconstruction of which should also be arranged for as soon as possible. These were those between (4) the Elephant and Castle, along Walworth Road, Camberwell Road, Peckham Road, High Street and Queen's Road and New Cross Gate; (5) Camberwell Green and the terminus at Vauxhall Bridge; and (6) Kennington Park Road and Brixton Road. With regard to tramways No. 2, it would probably be necessary for the Council to reconstruct the bridge carrying Old Kent Road over the Surrey Canal, but, owing to certain difficulties with regard to four railway bridges over other roads, the Committee considered that it was not advisable at present to make provision for the reconstruction of the tramways beyond New Cross Gate. With the exception of that portion and of the

cable tramway between Kennington and Streatham, the above lines, together with the Westminster—Tooting, &c., tramways, comprised the whole of the Council's tramways on the South side of the Thames. As to the cable line, which, during reconstruction for electric traction, would have to be worked by horse-power, the Committee did not think that the work should be taken in hand until some other portions of the tramway system had been converted, and the horses could be transferred for use on the cable line. By the adoption of that course it would not be necessary to purchase additional horses which would otherwise be required.

The specification and drawings for the track rails and fastenings and for the slot rails and conductor rails required for the reconstruction of the above tramways, equal to about 19¼ miles of single track, had been prepared by the tramway manager and the electrical engineer. Those gentlemen, the Committee mentioned, had prepared a report showing in what respects the specification differed very slightly from those of Prof. Kennedy for the Tooting, &c., lines. In the specification for the rails for the latter tramways, it was provided that the rails should be of British manufacture, and that restriction appeared to have had the effect of causing certain firms to refrain from tendering, as only four tenders were received for the supply of the track rails and two for the slot rails. The tenders for those two items had to be considered together, as they were so intimately connected with each other. In the present instance the Committee had thought it desirable to include the two classes of rails in one specification, and not to impose the restriction as to the rails being of British manufacture. It was necessary to submit description and drawings of the proposed system to the Board of Trade for approval, and to forward copies to the Borough Councils of Bermondsey, Camberwell, Deptford, Lambeth and Southwark in order that they might, if they so desired, make representations to the Board of Trade asking to be heard with regard to the projected system. A recommendation to this effect was postponed for a week in order that it might be considered in conjunction with a further report on the question. In this the Committee explained that in the case of the four bridges referred to in the preceding report the difficulty arises from the headway being insufficient to permit of the passage under the bridges of the type of car proposed to be used. The cost of reconstruction of the six lines is estimated at £644,350, of which £576,350 is for lines, plant, and rolling stock, and the remainder for new buildings and bridge reconstruction. The Committee will next week recommend the Council to sanction this expenditure.

Purchase of Tramways.—It was decided at the suggestion of the Highways Committee to convene a special meeting to consider the question of entering into an agreement with the South-Eastern Metropolitan Tramway Company for the purchase of the latter's undertaking. The Committee stated that the directors of the company were willing to recommend the shareholders to sell their system by agreement under Section 44 of the Tramways Act, 1870, for the sum of £50,000. At one point the company's tramways were in close contiguity with the Council's tramways, and it would only be necessary to construct a few yards of track in order to link up the two systems. The acquisition of the undertaking would assist in the further development of tramways in that district, and the Committee, therefore, considered that the purchase would be of advantage to the public. The price, of £50,000, was fair and reasonable, and the Committee mentioned that under the ordinary purchase clause of the Act, the company's lines could not be compulsorily acquired until 1909.

Shallow Underground Tramways.—It was stated by the Highways Committee that the tramway manager and the electrical engineer had presented their report on the construction and working of the subway tramway at Boston, U.S., and on the rapid transit subway now building in New York, and that Mr. J. A. Baker had appended a statement of his views at the request of the Committee. As the report would be of special interest to members and of great use for future reference, the Committee had given instructions for a copy to be supplied to each member, and a copy would also be supplied to the editor of each of the newspapers published in London. It was also intended to place copies on sale at 1s. each, and as the report was of great importance to London, the Committee recommended the Council to forward a sufficient number of copies to the City Corporation and the Borough Councils, in order that each member of those bodies might receive a copy. This proposal was adopted.

CORRESPONDENCE.

Coal Consumption per Unit in Power Stations.

After all "W. H. J.," is practically at one with me as regards load factor, since the highest ammeter reading is what I referred to as permitted by the circuit-breaker. It seems to me that the terms ought to be synonymous. I look on the maximum load in the same ratio to the circuit-breaker as I do working pressures in a steam boiler and the set of the safety valve. Otherwise, if I had an engine safe to run at 50 lbs. only, I would not load the safety valve, on even a strong boiler, to 100 lbs.

For an early definition of the load factor of a traction station, see Dr. Louis Bell, who defined it as "the ratio between average and maximum output."

As a matter of fact, is not the circuit breaker intended to limit the maximum output?

I don't follow "W. H. J." in his remarks *re* plant load factor, further than that the output varies for three-fourths of the time between $75x$ and $125x$; nor do I see what is meant by my being "supposed" to think that 50 per cent. plant will not generate 50 per cent. of output. In a station of which I know nothing, of course, plant is nothing to me. If the plant has a load factor of 100 per cent., all I can say is it was bought well, if it will stand double its rated capacity on a station load factor of 50 only; for the mean load being $100x$, the engine evidently is rated at $100x$, and the station load factor being 50 per cent., the maximum output must be $200x$.

Assuming the engines to be compound and arranged to give their double output with a cut-off in the H.P. cylinder of ¼ stroke, and a cylinder ratio of 1 : 3, the expansion at latest cut-off is 4 times; the mean pressure from, say, 150 lbs. initial is 93·4 lbs., one half of which, or, say, 46·7, represents about 11 expansions, as the rating of the engine for its makers' selling power. Thus, if the plant load factor is 100 per cent., and the station load factor is 50 per cent., the plant is loaded to 200 per cent. of its rated capacity at the short periods of maximum output, and must, therefore, have quite a wide range of loading. "W. H. J." tells us that the maximum load rarely exceeds 166 per cent. of minimum, a statement that is not quite reconcilable with a 50 per cent. station load factor. Indeed, except for the qualifying words "three-quarters of the run," and "rarely" the variation of only 25 per cent. above and below a certain output, points to a station factor of 80 per cent., which is probably more than is secured in any station in Great Britain without a battery; of course, this is an important point because load factors would always be higher than they are, if we could count them merely during full service hours, and not include shedding and unshedding of cars. This reduces the economy of working quite a little, and may justify the employment of sets of smaller size for such times. The plant load factor is really meaningless, unless we know steam pressure and cylinder capacities, when alone we can make use of the term. The question may be asked, What volume is generated by the L.P. piston per rated H.P.?

W. H. Booth.

London, *November 30th*, 1901.

Information Wanted.

I shall be glad to know if any of my fellow readers can suggest any means for making an ordinary lampholder absolutely watertight at the lamp socket, or know of any maker of such holders. I have tried the commercial watertight lampholder with rubber cord grip, and rubber sleeve over socket, the latter of which does not meet the requirements of the purpose, and utterly fails after a short time. For the purpose required, the lamps cannot be enclosed in watertight fittings.

Moisture.

Examination Test for Electrical Engineers.

In reply to the suggestion of the gentleman who signs himself "The Booster of the Middle Wire," I beg to say that I should be honoured and pleased to receive the names of any gentlemen who wish to help in starting this movement at my address, 99, Talbot Road, Bayswater, London, W. I should also be pleased to give whatever help I can to any committee that may be formed, as this is a matter in which I am greatly interested, and which I feel sure will greatly benefit a large number of engineers.

L. Francis Fogarty.

Poplar Union Electrical Works.

My attention has been called to certain correspondence in your last two issues as to some difference of opinion between the contractors for three motors in connection with these works, and an unsuccessful tenderer for the same. It is, of course, outside my province as consulting engineer to the Union to take notice of this controversy, but as my name has been mentioned in the letters, I thought it might lead to

misunderstanding. I may say that there has been no discussion by the Engineering Committee of the Poplar Union regarding this particular plant, except as to the payment of the trade union rate of wages.

You have, I know, referred to the trade union clause in your columns on many occasions, but I would mention that in this case the question of "boy" labour was dealt with fully by the Committee and Trade Society, the latter stating that it was quite in order for a "learner" to be employed with a fitter.

Referring to foreign plant, I was not concerned with the settlement of the contract referred to, but would mention that the tenders were fully considered by the Committee, particularly the next British tender (which was not the tender of Stephens, Smith & Co.). This British tender would have been accepted (although not the lowest) had it not been for the fact that it was for a new design of machine, and details as to the mechanical construction would not be given.

Regarding the sporting offers, a committee would not be justified in allowing their plant required for daily work to be placed in the hands of unsuccessful tenderers, so that they might gratify gambling instincts on the result of tests.

It appears to me that it would be preferable for Messrs. Stephens, Smith & Co. to study more closely the question of "competition" rather than bewail their fate and make incorrect statements in the technical press two years after the settlement of a contract.

As to my position, I may mention that I am in no way interested in either the successful or unsuccessful tenderers; or, in fact, in any manufacturing or contracting firms. I therefore hold quite an independent position as a consulting engineer, and my interests are the interests of my clients, having in view, at the same time, patriotism and justice.

F. J. Warden-Stevens.

Westminster, *December 3rd*, 1901.

Wireless Telegraphy in Italy.

Your article, "Wireless Telegraphy in Italy," in your issue of last week, is full of interest, showing, as it does, the steady progress made by the Italian Navy in the use of wireless telegraphy. It seems to me, however, that it may be misunderstood; I am sure, therefore, that you will allow me to avail myself of this opportunity of saying that Mr. Marconi has throughout received much kindness and encouragement from the Italian Government and the officers of the Army and Navy. The relations between Mr. Marconi and the Italian Government remain as cordial as ever; as a matter of fact, the Marquis de Solari, whose name you refer to in your article, has been working with Mr. Marconi in England for many weeks, and is at the present time working in one of our stations in this country.

I sent a copy of this letter to the Marquis de Solari, and he has written to me saying: "The whole of the Italian Navy will be very glad of your declaration of our friendly relationship with Marconi, and you can also say that I have come here to communicate the details of our work to him, and to complete our improvements with the enormous strides of the great inventor of the wireless telegraph."

S. Flood Page.

Marconi Wireless Telegraph Company,
December 4th, 1901.

The March of Municipalisation.

Some months ago you were kind enough to publish, under the heading, "Municipalisation or Monopolisation?" a warning and appeal to electrical contractors to combine, that emanated from my pen. Little did I imagine at the time that my fears were so soon to be realised, nor in such an emphatic manner as I found was the case on turning to my Electrical Review last Friday. The more one ponders over this question of municipalisation, the more one is driven to ask, "Where will it all end?" Six months ago the County Council were apparently satisfied with seeking powers to enable metropolitan municipal supply undertakings to undertake the wiring of private premises. Now, nothing short of the complete control of London's electricity supply will do. The very boldness of this latest scheme will ensure its receiving attention, though whether it will become law is another matter. But why, may we ask, has the Council taken up this new scheme, when the water supply and river steamboat service, of which so much has been said, still remain "as you were?" Surely these are more pressing needs that the Council might give their attention to than this effort to create a huge monopoly, that is, to say the least, unnecessary. If only we could see a reason for this wholesale "buying-up" policy, there would be no call for comment; but there is no reason, or if there be one, it is known only to the Council itself. Whether the idea is to create an immense communistic trust, or to prepare the way for the millennium, must remain a matter for conjecture. Be that as it may, the question of municipalisation has now become a burning one, and demands the serious consideration of not only the members of the electrical profession but every business man. The thin end of the wedge has already been driven in; it behoves the business men of London to see that it goes no further. This cool scheme to buy out the London electric supply companies, should it be successful, will only be the precursor of many more of a similar character—in fact, there are already whispers in the air anent the establishment of municipal markets. *En passant*, I may say that so keen is the spirit of municipalisation in some quarters, that in a certain metropolitan borough I wot of, in spite of certain expenditure having been declared illegal by the auditor at the last audit, the councillors are still continuing the expenditure. There is a Gilbertian flavour about this in the fact that when the amount illegally expended was surcharged, it was found that in place of the heroic councillors it was the poor town clerk that would have to suffer if the surcharge were enforced. So the auditor's decision is ignored, and according to latest advices this very Progressive council has now set up in the *milk trade*. If this can be done by a *borough* council, what are we to expect from the County Council? Progress is a very good thing doubtless, yet you may work a willing horse to death, and it does certainly seem as if the L.C.C. are going too fast and too far, so much so, indeed, that, owing to the removal of the stimulus of healthy competition, progression threatens to become retrogression, and municipalisation but another name for monopoly.

Sidney Frost.

Ventnor, *December 3rd*, 1901.

[Our correspondent will be interested in an article on page 953.—Eds. Elec. Rev.]

REVIEWS.

Gas and Fuel Analysis for Engineers. By Augustus H. Gill, S.B., Ph.D. Second Edition, Revised. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1901.

In the preface the author says that this book "is in no sense a copy of any other work, nor is it a mere compilation."

The appearance of a book bearing the above title, at a time when the economical combustion of fuel is so seriously engaging the minds of engineers and all power users, will no doubt attract attention, as any work that will assist engineers to procure a higher efficiency in the consumption of fuel for power purposes is sure to have a good reception.

In the introduction the author points out that with a knowledge of the chemical composition and temperature of the chimney gases and an analysis of the coal and ash, the loss due to imperfect combustion and to the temperature of the escaping gases can be determined. He instances as an example a case where, from the results of the gas analysis alone, he was able to increase the efficiency from 58 to 70 per cent.

After giving particulars relating to the taking of the samples and the various apparatus necessary, he goes on to describe some of the apparatus arranged for analysing the gases, including Orsat's, Bunte's and Elliott's systems. He, however, only considers engineers capable of determining the carbonic acid, oxygen and carbonic oxide, adding that the determination of the hydrocarbons is difficult for the

inexperienced and should be left to a competent chemist. We do not quite agree with his views in this case, as the addition to the apparatus necessary for determining hydrogen and the hydrocarbons increases the cost only slightly, and anyone who has mastered the manipulation of CO_2, O and CO determination by the apparatus described, could with a clear explanation make the further determinations of H, CH_4, &c., which would render an examination of generator or blast furnace gas of considerably more value in his investigations.

The following chapter deals with the calculations necessary to determine the efficiency of the combustion.

Solid, liquid, and gaseous fuels are clearly described, and formulæ showing the chemical composition are given in each case.

While the author has his doubts of the ability of an engineer to make determinations of the hydrocarbons in gas analysis apparatus, he further on gives details of analysis of fuels, which requires costly apparatus and considerable chemical experience, and which is hardly likely to be attempted by any but a chemist having a laboratory at his services.

Apparatus for ascertaining the heat value are fully described, and for those who can afford the outlay, they will be of considerable service, though these are mostly to be found in laboratories rather than in the hands of engineers.

The methods of calculating the heat value of various classes of fuel will be found very useful.

On page 48 there appears to be an error in the percentage of carbonic acid in blast furnace gas, for this usually ranges from 6·0 per cent. upwards to about 12·0 per cent. Some useful tables are given in the appendix.

Whether furnished with apparatus or no, a study of Mr. Gill's work will be of considerable help to all those not thoroughly grounded in the chemistry of combustion of fuel.

The Induction Motor. By B. A. Behrend. New York: *Electrical World and Engineer.* 1901.

The keynote of this book is given on the title page, where the author takes a quotation from the writings of Prof. J. J. Thomson.

"The absence of analytical difficulties allows attention to be more easily concentrated on the physical aspects of the question, and thus gives the student a more vivid idea and a more manageable grasp of the subject than he would be likely to attain if he merely regarded electrical phenomena through a cloud of analytical symbols."

The book is certainly free from *analytical* difficulties, inasmuch as it contains no mathematical analysis whatever. The results are deduced geometrically, but not always without difficulties.

We presume that by analysis is meant calculations performed by the aid of algebra in contra-distinction to geometrical methods.

It is impossible for us to take the view that geometrical methods are always superior to algebraical analysis. Sometimes diagrams become so intricate and complicated, that the sight of them is sufficient to bewilder and dismay. Sometimes, on the other hand, a simple diagram can teach more than pages of algebra. The best way is to combine algebra and geometry, so as to expound the subject most clearly.

It is difficult to imagine a simpler or more concise method than that of vector algebra, which combines the simplicity of easy algebra with the lucidity of geometrical methods. If we have to attack the problem of determining the equivalent impedance of several mutually inductive circuits arranged in parallel, the method of vector algebra is immensely superior to either geometry or commutative algebra.

Mr. Behrend has, however, employed the geometrical method very effectively, and has avoided the use of complicated diagrams. His chief fault is occasional brevity at the expense of sufficient explanation. It is not wise to expect readers of books to be capable of solving geometrical riders, especially when the book happens to lay claim to an elementary treatment of the subject. This fault is not uncommon with writers who, themselves masters of their subject, forget that their readers may not be able to supply for themselves the omitted parts which lead up to the result attained. Any expert can write a book on his subject which will be intelligible to similar experts; but to write for the ignorant, for those seeking knowledge, he must have the faculty of imparting his knowledge; in other words, he must be a teacher as well as an expert.

The book is essentially one for engineers engaged in alternating current work, and as such supplies a want. Designers of alternating current motors should certainly study it carefully: they will find much that is useful. The chapters on "The Leakage Factor" and the design of three-phase and single-phase motors are especially good and useful.

The whole problem of the design of inductive motors is one of how to reduce magnetic leakage. The power factor of induction motors is low because there is large leakage; that of stationary transformers is high because the leakage is low. These points are so well dealt with that any engineer engaged in this class of work will be amply repaid for the time spent in making a thorough and careful study of the book.

The Calorific Power of Fuels. By Hermann Poole. New York: John Wiley & Sons. London: Chapman and Hall, 1901.

This is, perhaps, the best book on fuels generally that has yet appeared, and though essentially intended for American practice, the treatment of the subject is quite standard, and the American element is only prominent in that the fuel tables are more detailed for American coals. At the same time, the tables of other coals are good, especially for India and Germany. Curiously enough, the table of British coals is one of the briefest, being hardly larger than that for Bulgaria. Indeed, both Yorkshire and Staffordshire are ignored.

The work was commenced as a translation of Scheurer-Kestner's work on combustibles, but it was found desirable entirely to remodel the book, though most of the cuts are from the original work. It is hardly necessary to say that coal occupies most of the space, though wood, peat, gas and oil are also dealt with. Though sulphur is a constituent of most fuels, and is itself a fuel, there are really but two elementary fuels, hydrogen and carbon. These two elements alone, or combined with each other or other substances, form the basis for all fuels. If we know how much hydrogen or carbon exists in a given fuel we can closely approximate to the power of that fuel. The result is modified by the state of chemical action already attained, as, for example, where some of the hydrogen has already been oxidised, and its further calorific capacity shut off to that extent.

Dulong has long been accepted as a great authority on combustion. His formula for calorific capacity was

$$x = 8{,}080\ \mathrm{C} + 34{,}500\left(\mathrm{H} - \frac{0}{8}\right).$$

This formula thus took cognisance of the oxygen. Various other formulæ have been suggested, but probably Dulong's formula is as close as can be expected for calculation. The actual calorific capacity of a fuel is only to be found by experiment. Chapter III. deals with experimental calorimetry and describes calorimeters, and gives very full details of their construction and working and of the calculations and corrections to be made in using them. This matter continues to the end of Chapter VI.

In Chapter VII. solid fuels are described generally; liquid fuels follow, the value of which is enhanced by the fact that they are liquid, and therefore for equal weights of carbon and hydrogen must have a value superior to solid fuel, in so far as the heat of gasifying a liquid is less than the heat of gasifying a solid.

In this connection the author refers to Admiral Selwyn's tests in 1884, when he obtained an evaporation of 46 lbs. of water per pound of liquid fuel. Given a heat of evaporation of water of 966 units and a calorific capacity of 22,628 units for the best petroleum fuel quoted at page 90, we cannot see how it is that the author passes the 46 lbs. of evaporation with so little remark. It is scarcely probable that petroleum fuels are endothermic to such an extent as would be demanded by an evaporation of 46 lbs. of water per pound of fuel.

Even acetylene and benzine are only endothermic to the extent of about 20 and 22 per cent. above the Dulong formula. We certainly do not think that evaporations of 46 lbs. are to be lightly accepted as probable, for no hydrocarbon appears to contain over one-seventh its weight of hydrogen. We seem to remember hearing a few years ago about some wonderful evaporations, and a claim that nitrogen had been induced to combine with oxygen in the furnace, and if we rightly remember, this was most strongly stated. It would indeed be serious if nitrogen had been, or could be, so combined in large quantities. The author ought seriously to examine this huge evaporation, and the sources of his information.

Gaseous fuels are next dealt with, including producer gas, the generation of which is clearly explained in respect to its thermic absorptions.

In Chapter X. the use of coal under steam boilers is treated of, with methods of boiler testing, coal sampling, analysis, and quality of steam in respect of moisture. In the next chapter air supply and combustion is dealt with on its practical side, including the sampling of waste gases and calculation of volumes from analysis. Anemometers are described, also the econometer and other necessary instruments. The Ringelmann smoke scale is illustrated. We have used this scale ourselves, and found it satisfactory as a means of estimating the quality of smoke by colour.

The following chapters are calorific, and deal with heat distribution and temperature of flame; the question of dissociation is referred to in connection with maximum temperatures, a subject that is very little understood as yet, and is complicated by the double action of dissociation and variation of specific heat at high temperatures.

The physics of carbon are well treated, and the author is clear on the effects of allotropism. He is content to assume that the heat of the first oxidation of carbon is equal to that of the second oxidation, though it is thought by Berthelot to be greater by a number unknown, and he accepts the difference of heat output as the latent heat of vaporising solid carbon. In an appendix are given the rules of the American Society of Mechanical Engineers for conducting boiler trials, and the volume closes with a valuable series of tables of gases and their properties, of the coals of various countries, of oils and gaseous fuels.

As the book is based on a European original, and does not deal with boiler forms, but merely with fuels, it is thoroughly general in its teachings, and is one of the best books on its subject that we know.

We note what appears to be an error. The fuel tables give the percentage composition of all the constituents of coal so as to total up to 100, including water and ash. A statement on page 114, however, states that the water and ash are not included in the sum total of 100 per cent., but are additional. This is done in a few instances with some of the Russian coals, but not for all the Russian coals, so that the tables are somewhat misleading. The German tables are given on both systems by request of Prof. H. Bunte.

THE MANUFACTURE OF ELECTRODES.

An article by Mons. G. Strauss has recently appeared in the *Revue Générale de Chimie Pure et Appliqué* which describes the process employed for manufacturing and testing electrodes at the factory belonging to the Société des Carbures Métalliques. This company owns several calcium carbide works, which are situated at Notre Dame de Briançon, Le Castelet, Bellegarde, and Berga. The electrode factory is at the first-named place, on the right bank of the Isère, just opposite the carbide works, with which it is connected by means of a bridge. It consists of three buildings containing respectively crushing machinery, mixing and compressing plant, and the ovens and gas producers. Power is derived from a 225-H.P. turbine and an electrical motor driven by a 200-volt 95-ampere alternating current, transformed on the spot from part of the 15,000-volt supply delivered to the carbide factory from the central station at Radja. The raw materials used are three in number—retort carbon, petroleum coke, and coal tar. The first is obtained in varying qualities, from soft to hard, from light grey to pure black, and has to be thoroughly mixed up in order to produce a homogeneous product. Originally, retort carbon cost about 50 francs per ton; but owing to the great demand for it, it is becoming difficult to procure, and now costs about 150 francs. Petroleum coke, a shining black porous body, is the residue of crude petroleum distillation. It is employed chiefly in the manufacture of specially hard electrodes, such as are required for igneous electrolysis. As bought, this coke is very pure, containing less than 1 per cent. of ash and no volatile constituents. The coal tar is either a product refined from ammonia, distilling between 240° and 330° C., and having a specific gravity of 1·283; or else it is an artificial mixture prepared from pitch by solution at a steam heat in a heavy tar oil. The carbon is first crushed in machines fitted with hard cast-iron jaws, and then passed through a series of sieves to grade it into powder of varying degrees of fineness, the final sub-division of the powder being dependent upon the diameter of the electrodes made. Next the powder is mixed in steam-jacketed apparatus with the necessary proportion of tar, and ground under edge-runners, the rollers of which weigh 3,500 kilos. As it leaves the grinding machines the mixture forms a thin flat cake, hard, but flexible, and it is then ready to be moulded into shape. There are two methods commonly adopted for forming the electrodes — by simple pressure, or by extrusion, *i.e.*, forcing the material through a draw-plate. The latter method requires more costly apparatus, but gives a more uniform product, and is employed at the works now being described. When electrodes of less than 200 sq. cm. in cross-section are being manufactured, the material from the edge runners is charged into stamping presses, the lower halves of which are split steel mortars, the upper halves being steel stamps weighing 500 kilos., which are made to fall on the mass through a distance of 1 metre. In this fashion "cartridges" are prepared that weigh between 180 and 220 kilos. each. These are placed in steam-jacketed hydraulic presses, and by means of a pressure of 500 or 600 atmospheres, the material is forced through holes at the opposite end of the press. When larger electrodes have to be made, the "cartridges" are formed by hydraulic pressure in the casing of the hydraulic extrusion press itself, using a pressure of from 150 to 500 atmospheres, and they weigh no less than 1 ton each. Finally they are similarly extruded under a piston giving a pressure of 2,000 tons. Before this larger plant was laid down, electrodes of from 500 to 900 sq. cm. in area were manufactured by cementing. Smaller carbons were painted with tar, fastened together with screw plates, and burnt into a solid mass. The stoving is done in a Siemens regenerative furnace working continuously. The electrodes are loaded into muffles, the empty space in which is filled up with carbon dust, and put into the furnace, and the arrangement of flues is such that each muffle is gradually warmed up for five or six days before it is exposed to the full heat of the stove.

In order to test the conductivity of these electrodes, a sample is fastened upright in a metal mould 20 or 30 mm. high, and molten lead is poured in. The same is done at the other end, and then a hole is made in each casting which is filled with mercury. The exact distance apart of the mercury contacts is measured, and the resistivity of the carbon is determined by means of a Thomson's bridge arranged for low resistances. The electrical properties of such carbons vary greatly according to the nature of the raw materials employed in their manufacture; and they are also affected by the manufacturing process, as well as by the way in which the burning is carried out. To exemplify this, M. Strauss quotes the following tests:—A Swiss electrode was taken, 900 sq. cm. in section, and of perfectly sound appearance. On measurement it gave the bad result of $a = 14{,}837$ microhm-centimetres. A French specimen which appeared to be much inferior, gave $a = 8{,}872$. A German electrode, of the same size, made by the "extrusion" process, gave $a = 6{,}790$; while the products of the Société des Carbures Métalliques give values ranging between 6,000 and 6,200 microhm-centimetres. The specific resistance, however, of these carbons decreases with their diameter. To show that the temperature and duration of the stoving process affect the resistivity of electrodes,

M. Strauss mentions an experiment where a carbon 30 cm. long and 10 × 10 cm. in area was placed between four others 20 × 10 cm. in size, and the five burnt together. On examination, the central rod gave $a = 6{,}700$, and the external ones $a = 5{,}800$. This increase in resistivity as the electrode is larger in size is due to the fact that the internal portion of the rod is burnt less thoroughly than the exterior, and imperfectly burnt material conducts badly. In conclusion, M. Strauss appends a table of the specific resistances of carbons of different thicknesses, in which the extreme values are: 2 cm., 5,000; 3 cm., 5,079—5,194; 25 cm., 5,484—5,548; 30 cm., 5,943—6,261.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Dec. 4th, 1900.		Week ending Dec. 3rd, 1901.	
Amsterdam	Value £27	Adelaide	Value £342
Antofagasta. Teleg. mat.	157	,, Teleg. apparatus	2,613
Auckland	54	Alexandria	296
Bombay	195	Buenos Ayres	459
Calcutta	1,270	,, Teleg. cable	85
Cape Town	377	,, Teleg. mat.	1,126
Colombo	46	Calcutta	1,539
Copenhagen	18	Cape Town	90
,, Teleg. wire	109	Channel Islands	8
Demerara. Teleg. mat.	996	Chinde	79
Durban	315	Copenhagen	260
East London. Teleg. mat.	346	,, Teleg. wire	214
Fremantle	444	Durban	865
Gothenburg. Teleg. wire	22	East London	59
Halifax. Teleg. paper	164	,, Teleg. mat.	217
Hamburg. Teleg. mat.	300	Fremantle	850
,, Teleg. wire	45	Gothenburg	65
Malta	219	Lyttleton	65
Melbourne	164	Melbourne	400
,, Teleg. mat.	1,569	,, Teleg. mat.	342
Nordenham. Teleg. cable	1,000	Ostend	220
Ostend	696	Port Elizabeth	213
Penang. Teleg. mat.	156	Rio Janeiro	200
Port Elizabeth	100	Stockholm. Teleg. wire	67
Rio Grande. Teleg. mat.	60	,, Teleph. mat.	148
Rio Janeiro	31	Sydney	757
,, Teleg. mat	801	Tokio	49
,, Telephones	50	Valparaiso	60
Rosario	53	Wellington	91
Rotterdam. Teleg. wire	21		
St. Petersburg	30		
Santiago de Chili	213		
Santos. Teleg. mat.	34		
Sydney	1,122		
,, Elec. lighting machinery	3,125		
Valparaiso	55		
Wellington	64		
Total	£14,443	Total	£11,779

Foreign Goods Transhipped.

Brisbane. Teleph. appar.	Value £1,012	Durban. Telephones	Value £87
Hamburg. Elec. mat.	205	New York. Elec. mat.	33
Total	£1,217	Total	£120

Applications for Parliamentary Powers, Session 1901—02.—The following is the concluding portion of the applications which are being lodged at the present moment with the Board of Trade and Parliament for electric lighting, power, tramway and railway powers. The full notices will be found in the *London Gazette* for November 26th and 29th.

Electric Lighting.

Morpeth, Ashington, Newbiggin-by-the-Sea, Bedlingtonshire, and Morpeth [Rural] (Northern Counties Electricity Supply Company, Limited); Barton Regis (District Council); Leadgate (Northern Counties Electricity Supply Company); Stevenage (U.D.C.); Hitchin (U.D.C.); Knutsford Light and Water Company (power to accept transfer of the Knutsford U.D.C. electric lighting undertaking and to apply for electric lighting powers); Louth (Corporation); Southwark (Borough Council); Newburn (Newcastle and District Electric Lighting Company); Stanley and Tanfield (Northern Counties Electricity Supply Company); Stockton (U.D.C.); Seghill, Earsdon and Tynemouth [Rural] (Northern Counties Electricity Supply Company); Amble (Northern Counties Electricity Supply Company); Felixstowe and Walton (U.D.C., general powers, including supply of electrical fittings, exemption from liability to supply electricity in certain cases and prohibition of overhead wires); Tottenham (U.D.C.); Cleethorpes (U.D.C., supply of electric fittings, exemption from supply in certain cases, tramway powers and purchase of generating station of the Great Grimsby Street Tramways Company); Camberwell (Borough Council); Trefiew (Llandwrst Electricity Supply Company); West Riding (West Riding Tramways and Electricity Supply Company); Church Stretton (Church Stretton Land Company, Limited); Norwich (Corporation, purchase of company's undertaking); Lees (U.D.C.); Leatherhead and District (Leatherhead and District Electricity Supply Company); Chiswick (U.D.C.); Paignton (U.D.C.); Chepstow (Chepstow Electric Lighting and Power Company); Paignton (Provincial Electric Supply and Traction Company); Dover (Corporation, purchase of undertaking from company, &c.).

Tramways and Light Railways.

Preston and Lytham; Croydon and District (B.E.T. Co.); Hounslow, Slough and Datchet (Metropolitan District Electric Traction Company); Cheadle and Gatley (U.D.C.); Lees (U.D.C.); Accrington and Burnley (Auxiliary and Light Railways and Tramways Company); London United Company (new tramways in London, Middlesex and Surrey, and various other powers); South Shields, Sunderland and District (B.E.T. Co.); Rossendale Valley (Rossendale Valley Tramway Company, adaptation of old and construction of new lines); Heywood (Corporation); Mountain Ash (U.D.C.); Swansea (Corporation, new tramways and other powers); Salford (Corporation, construction of new lines and alteration of existing; joint board to work tramways now worked by Manchester and Salford respectively); Todmorden (Corporation); Scarborough (new company, various lines); London United Company (Light Railway Extensions, No. 26); Exeter and District (new company); Tottenham and Walthamstow Tramways (Metropolitan Tramways and Omnibus Company); Southport (Corporation); Hove, Worthing and District (Brighton and Shoreham Tramways Company); Walker (U.D.C.); Saddleworth, Springhead and Lees (new company); West Riding (Knottingly extension, West Riding Tramways and Electricity Supply Company); Wrexham District (extensions W. & D. Electric Tramways, Limited); Hastings (extension, Hastings Tramways Company); Torquay and Paignton (new company); Llandudno and Colwyn Bay (light railway, Llandudno, Colwyn Bay and Rhyl Electric Traction Company); Dover, St. Margaret's and Martin Mill (Sir W. Pearson, Sir J. Jackson and Sir W. Crundall); Bournemouth (Corporation); Dover River and Alkham Valley Light Railways (Sir W. Crundall, R. Tritton, G. and A. Clark); Windsor and Maidenhead Light Railway (Metropolitan District Electric Traction Company); Clacton-on-Sea and St. Osyth (new company); Warrington (Corporation); Dudley and Rowley Regis (Dudley and Rowley Regis Councils); Watford and District (Watford and District Tramways Company); Barnsley and Doncaster Light Railway; Southend-on-Sea and District, Bradwell-on-Sea and Colchester Light Railways; London United Tramways (Light Railway Extensions, No. 2); Torquay and Paignton (new company); Canterbury and Herne Bay: West Manchester Light Railway (extensions and amendment, West Manchester Light Railway Company); Leeds (Corporation); Walthamstow and District (U.D.C.); Wakefield and District Light Railway (Dewsbury and Castleford extensions); Pontypridd (U.D.C.); Nottingham Suburban (new company); Derby and Nottingham (new company); Chiswick (U.D.C.); Crystal Palace Light Railways (Crystal Palace Light Railways and Tramways Company); Wolverhampton (Corporation); Torquay and Paignton (Provincial Electric Supply and Traction Company).

Underground and Other Railways.

Baker Street and Waterloo (extension of time and other powers); Manchester City Circle Railway (powers to a company to construct a circular underground railway from a point near Victoria Station); London United Electric Railways (new company, construction of underground railways from Shepherd's Bush and Hammersmith to Barnes, Charing Cross, Clapham Junction, and Marble Arch; also agreements with London United Tramways, Limited, and other companies); City and Crystal Palace Railway (various powers, including electrical working); Metropolitan Railway (various powers, including electrical working); London and Brighton Electric Railway (new company): Edgware and Hampstead (sundry powers to a new company, generating station); City, Wandsworth and Wimbledon (new company, underground electric lines); Charing Cross, Hammersmith and District (underground railways and subways from Hammersmith to Barnes, from West Strand to River Thames, from Strand to Piccadilly Circus, from Piccadilly Circus to Hyde Park Corner, new company); Victoria, Kennington, and Greenwich (new company, underground and electric lines); Piccadilly and City Railway (No. 2); North-East London Railway (No. 2, underground lines in London, Middlesex, and Herts); East London, City and Peckham (underground railways from Plastow to Gracechurch Street and Peckham, new company).

Electric Power Schemes and Miscellaneous.

Manchester District Telephone Board (Powers to Manchester, Salford, Stockport, Eccles, Stretford and Gorton Councils, to provide telephonic communication in and around Manchester); National Telephone Company (Powers *re* Manchester area); Ashton-under-Lyne (Corporation, extension of tramway and electric lighting powers); Cornwall Electric Power (New Company generating station, supply of electricity in the County of Cornwall); National Telephone Company (Kingston-upon-Hull, application of Sec. 3 of Telegraph Act, 1899, to agreements between the company and the Corporation).

Private Bills Legislation.

Our Parliamentary correspondent writes:—On Saturday 318 plans in connection with private or local Bills in promotion for the ensuing session of 1902 were deposited at the Private Bill Office. Amongst the electric Bills were the following:—

Railways.—London and Brighton Electric; Manchester and Liverpool Electric Express; Great Northern and City; City and Crystal Palace; North and South Shields Electric; King's Road Extension; Edgeware and Hampstead; Brompton and Piccadilly (new lines and extensions); Metropolitan District Railway; City, Wandsworth and Wimbledon; Charing Cross, Hammersmith and District; Great Northern and Strand; City and North-East Suburban Electric (No. 2); London United Electric; Central London Railway (new lines); Metropolitan, Charing Cross, Euston and Hampstead (No. 3);

East London, City and Peckham; Piccadilly and City Railway (No. 2); and North-East London Railway (No. 2).

Tramway.—Tyneside Tramways and Tramroads Company (new lines); Romford Urban District Council; Rhondda U.D.C.; Hove, Worthing and District Trams; Wrexham District (extension); Birmingham and Midland Trams; Scarborough Trams; Erdington Trams; Mexboro' and Swinton Trams; L.C.C. (Subways and Tramways); Northumberland Electric Trams (Morpeth to Beddington, Bebside to Blyth, and Ashington to Newbiggin); Croydon and District Electric; South Shields, Sunderland and District; Torquay and Paignton, Saddleworth, Springhead and Lees; North Ormsby, South Bank and Grangetown Trams; Newcastle Corporation Extension; Hastings Trams; Brighton and Rottingdean Seashore Electric; Rossendale Valley; York Corporation; Manchester Corporation; and London United Tramways.

Power Bills.—Cornwall Electric Power; Northumberland Electric Power; Leicester and Warwickshire Electric Power; Kent Electric Power; Gloucestershire Electric Power; South Wales Electrical Power Distribution Company.

Electric Lighting Provisional Orders.—Tottenham; Stockton; Eston; Stoke Newington; Saddleworth; Glasgow; Lees; Morpeth, Ashington; Newbiggin-by-the-Sea; Bedlingtonshire and Morpeth (Rural); Seghill, Earsdon and Tynemouth (Rural); Stanley and Tanfield; Chiswick; Leadgate; Bournemouth; Newburn; Nairn; Amble; Dumbarton; Wood Green; Leyland; Beeston; Hebden Bridge; Hucknall Torkard; Enfield; Blaydon; Holyhead; Chesterle-Street; Dover; Lowth; Paignton; Barton Regis; East and West Molesey; Chepstow; Carnoustie; St. Andrews; Thornaby-on-Tees; Govan; Woolwich; South Banch-in-Normanby; Trefiew; West Naughton; Church Stretton; Stanley; Paignton; West Riding; Mytholmroyd; Gillingham; Hindhead and District; Tipton; Camberwell; Stevenage; Hitchin; Southwark; Leatherhead and District; Cowes; Aberdeen; Otley; Slough; Springhead; Edmonton; Tadcaster and District; Pokesdown; and Frinton-on-Sea.

Tramway Provisional Orders.—Greenock and Port Glasgow Extension; Lees Urban District Council; Stockport Corporation; Chiswick Urban District; Aberdeen Suburban; Bournemouth Corporation; West Riding (Knottingley Extension); Torquay and Paignton; Sunderland Corporation; Southampton Corporation; Brighton Corporation; Todmorden Corporation; Rothesay Extension; Southport Corporation; Aberdare; Walker Urban District; Cheadle and Gatley Urban District; and Mountain Ash.

Books Received.—"Grundriss der Elektrotechnik (Kraftübertragung, Bahnen und Automobile, Kosten elektrischer Anlagen und Sicherheitsvorschriften)," by Heinrich Kratzert. Leipzig and Wien: Franz Deuticke. 1901. Mks. 6.

"Grundriss der Elektrotechnik (Elektriche Beleuchtung)." Leipzig und Wien: Franz Deuticke. 1902. Mks. 10.

"Knowledge Diary and Scientific Handbook for 1902." London: *Knowledge* Office. 3s. net.

Catalogues, &c.—The General Electric Company have sent us a copy of their electric glow radiator circular. The lamps used in these radiators are of the "Robertson" type, each absorbing 300 watts.

Messrs. Haycraft & Son, Limited, of Deptford, send us an illustrated circular of their American steam motor cars.

A new catalogue of the "Evershed" soft-iron instruments has been brought out by Messrs. Evershed & Vignoles, Limited, who, by the way, have a City office at 110, Cannon Street, E.C., in charge of Mr. P. F. Brittain, where all information respecting the "Evershed moving coil and soft iron instruments" can be obtained, and the instruments seen. We have also received from this firm a new list of their testing set.

The B.T.H. Company's November 25th list, No. 114, is devoted to a description of their magnetic blow-out series parallel controllers, types K and L, for electric cars and locomotives. It is fully illustrated, with street views of lines where B.T.H. controllers are in service.

Messrs. Marshall & Woods, Gray's Inn Road, W.C., have brought out a list of their improved electric lamps for the light treatment of lupus and other skin diseases. Their Lortet and Genoud apparatus was recently described in the Electrical Review.

Messrs. Offord, Wilson & Barfield, of Birmingham, have sent us advance sheets of their brass case meters and new cast-iron wall plug. The meters have been designed with a view to strength and cheapness, and we understand have been found satisfactory in practice. The wall plugs have been used in large quantities for factory and workshop lighting, a purpose for which they were specially designed. The makers are also manufacturers of various other apparatus, including theatre accessories, aluminium case galvanometers, time switches, automatic switches, and resistances.

Messrs. Falk, Stadelmann & Co. have issued a supplement to their bell catalogue. It details telephonic apparatus, electro-medical apparatus, and accessories.

Messrs. O. Berend & Co. have sent us circulars of their petroleum torches, blow lamps, &c.

Messrs. Geipel & Lange are sending out circulars and illustrations of their high resistance field rheostats for boosters, balancers and motor-generators, which are made for any resistance from 5 to 10,000 ohms. The resistance is mounted in the form of small units on the back of a slate panel on the front of which are contacts travelled over by a lever which varies the resistance as desired. These units are of the Ward-Leonard enamel pattern, and consist of pottery tubes wound with the resistance material and covered with porcelain enamel which effectually protects it from contact with the atmosphere. The current-carrying wire can therefore be kept extremely small and run at a high temperature without deterioration. Thus a switch of compact form is made possible. One pattern is for the back of switchboard, the other is for the front of switchboard or for fixing on a wall. Each pattern is made with either 25 or 50 steps, and the slate front is only 12 in. square.

Mr. G. Braulik sends us a copy of his List No. 17, detailing various kinds of measuring instruments.

The Bryant Trading Syndicate, Limited, electrical importers and exporters, of 16, Guildford Street, Leeds, have sent us a copy of a report by Prof. G. D. Aspinall Parr, on their china and porcelain electrical pendant fittings and shades. The company is shortly to issue a list of these specialities. Readers may obtain copies of the report by writing to the above address.

A list of carbons for electrical purposes comes to hand from Fabius Henrion, of Nancy.

Cork Exhibition.—All applications for space at the Cork International Exhibition have to be lodged by January 15th. All communications should be addressed to the Secretary, Department of Agriculture and Technical Instruction of Ireland, Upper Merrion Street, Dublin. Manufacturers of machinery are requested to make a special note of the above date and address, or, better still, to apply at once.

Dissolution.—Messrs. H. E. Richardson and J. H. McLaren, electrical engineers, North Finchley, have dissolved partnership.

Epstein Accumulators: Messrs. W. O. Rooper and Co.'s Factory at Stafford.—It is now some time since Messrs. W. O. Rooper & Co., of Stafford, commenced to manufacture, under license, the well-known Epstein storage batteries. From time to time it has been our pleasant duty to publish particulars of tests which have shown this type to be of the first class, both as regards life and service.

We have recently had the opportunity of inspecting the factory and observing the various processes of manufacture under the guidance of Mr. Vicarey, who was for many years associated with the late Mr. Epstein as his laboratory assistant, both with the experimental work and the actual manufacture at the Epstein Company's works at Milton, Staffordshire. Mr. Vicarey is now works manager for Messrs. Rooper, which augurs well for the careful attention to detail necessary for the production of a first-class accumulator.

The works, situated about 10 minutes' walk from the station, were originally occupied by a brewery company, and with slight alterations have been admirably adapted for their present purpose. The building itself is so large that a separate shop is provided for every process, a distinct advantage in any works where lead is chemically treated. The yard accommodation is very considerable, and will also allow of more than doubling the present premises.

Following the guidance of the manager, the power house was first visited; here the Corporation supply at 420 volts is transformed to suit the varying requirements of the processes. The switchboard admits of many combinations of town supply, dynamos and batteries, to suit the requirements of the forming rooms.

The battery we saw working consists of 108 cells, and it is worthy of note here that most of the plates of which it consists have been in constant use for four years, or longer, some of them as long as six years, without any sign of deterioration. The capacity is 1,000 ampere-hours, and has to supply all demands that may be put upon it. This battery is housed in an outbuilding adjoining the power house. Being a permanency, the plates are burnt together in sets to a common bar, which again is burnt to the corresponding bar of the adjacent cell.

To follow the plates through their various processes, we visited the casting room, where the lead, which is absolutely chemically pure, is cast in moulds. The centre web varies from 2 mm. to 3 mm. in thickness; the grooves vary from 3½ mm. to 4 mm. in depth; the area of surface presented for active use is therefore about five times the plane surface. The plates are then trimmed on a circular saw driven electrically, pressed, and then immersed in the boiling or pickling baths in dilute acids; no washing is necessary, as the acid is practically "killed" during the process of pickling. From the boiling room the plates are removed to the drying room, where they are dried in a temperature of 100° F., in suitable separating racks for a period of not less than 24 hours. After drying, the plates are placed in the forming cells, and temporarily connected by lead burning, the formation electrolyte being then placed in the cells and forming commenced.

The forming occupies roughly 150 hours, and is taken in three stages; the first about 50 hours, the second 40—60 hours, and the final 40—50 hours, the current varying from 7½ to 28 amperes per plate. Between each formation the plates are removed and inspected, after which they are tested by successive charges and discharges. The plates are then removed to the plumbers' shop, where they are built up into sections.

The process is, as will be seen, extremely simple and straightforward, but occupies a considerable time, the period required to make a finished plate from the pig lead being 21 days. There is no doubt but that the time occupied in the manufacture, and the care bestowed on every detail, are responsible for the extraordinary length of life and capabilities of this now well-known type of plate.

The joiners' shop and packing shop call for only passing mention. The plumbers' shop, where lugs are burned on when necessary, calls for more attention, as it is here that all small detached parts are manufactured, including Rooper's ingenious connection, which we mentioned some months ago. This connection relies for its success on the ductility of lead and in use for connecting up the plates of a cell has proved most successful after lengthy trials. Everyone

knows the difficulty in raising out of a cell a section containing many plates. With this connection the plates have a slotted disc lug burned on at one corner; into the slot is placed a lead coated pin with screwed ends on which are threaded lead washers of suitable thickness to act as distance pieces, the whole being screwed firmly together by means of lead-coated nuts, until perfect contact is obtained. About 12,000 plates have already been erected on this system with absolute success. The surfaces of the lead are so intimate that the acid cannot creep and destroy the contacts by sulphating. Of course large numbers of plates are still burned up in the ordinary way.

The acid vats, formerly malt tubs, lined with lead, are at the top of the building, and all acid is pumped up to these from the precipitating tanks, mixed to the proper sp. gr., analysed and used again. The sulphate of lead deposited in the pits is a valuable waste, which finds a ready market.

Leaving the workshops, we pass to the laboratory, where every material is analysed, it being fully established that when plates or cells have failed in the past it has been due to impurities, especially in the acids, which must be chemically pure, free from arsenic (not always so in breweries), and in this connection it may be well to say that Messrs. Rooper will always analyse acids, free of cost, for their customers.

Of the Epstein cells we need say little; carefully and properly made they are thoroughly satisfactory, their capacity is good, and their life long, while from their construction the plates are as free from buckling under undue discharge rates, as any other makes, and being pure lead are easily straightened. At present they are put on the market in the A, B, and C types, the latter being semi-portable, while a portable cell is contemplated in the near future. Full particulars as to capacity, &c., are given in the maker's catalogues.

Among the large numbers of batteries of the Epstein type in use may be mentioned those at the Birmingham Corporation Meat Market; Messrs. Willans & Robinson, Limited, Rugby; the Midland Railway at various places; Eaton Hall, Chester; Staffordshire County Asylum; Berkshire Asylum; H.M.'s Dockyards; Woolwich Arsenal; and at Goodrich Court, Ross, Herefordshire (in this instance the battery has been in use for nine years, and now practically has as good a capacity as ever).

For Sale.—Barnsley Corporation wants to sell a 75-KW. high speed steam dynamo.

France.—La Société de l'Accumulateur Bainville is the name of a company which has just been formed in Paris with a capital of £2,000.

Mansion House Charge.—We are informed that at the Mansion House on Monday, before Mr. Alderman Vaughan Morgan, Wm. Geo. Bradley, an assistant wireman, of 37A, Juniper Street, Shadwell, was charged with obtaining goods from the General Electric Company, of Queen Victoria Street, by means of forged orders; and Abraham Goldsmith, electrician, of 237, Whitechapel Road, was charged with feloniously receiving such goods from Bradley, well knowing them to have been fraudulently obtained. The prisoner Bradley, it was alleged, had obtained the goods on official order forms stolen from the order book of Messrs. G. Weston and Co., electrical engineers, of 58, Fenchurch Street. Formal evidence of arrest, &c., having been given, the accused were remanded until Friday, the Alderman agreeing to accept bail of £500 for Goldsmith.

Micanite.—Our American contemporaries publish a notice from the Mica Insulator Company, of New York, to the effect that the validity of their American and European patents has been acknowledged by the following powerful electrical manufacturing concerns:—General Electric Company, Schenectady; Westinghouse Electric and Manufacturing Co., Pittsburg; the British Westinghouse Electric and Manufacturing Company, London; the Westinghouse Electric Company, Limited, London; the British Thomson-Houston Company, Limited, London; Allgemeine Elektricitäts Gesellschaft, Berlin. In view of the litigation that took place a year or so ago and its result, the outcome of the actions, which, we understand, have again been started will be watched by all concerned with infinite interest. Since the material has been universally used, the question raised again is an extensive one.

Stamp Duty.—In the Court of Appeal on Thursday last week, before the Master of the Rolls and Lords Justices Stirling and Mathew, the case of the Attorney-General *v.* the Mayor and Corporation of the borough of Eastbourne came on for argument. It appeared that in 1899 the Eastbourne Electric Light Company, Limited, entered into an agreement with the Mayor and Corporation of Eastbourne for the sale of the undertaking to the Corporation. In order to carry out the agreement a conveyance was executed, and the question before the Court was the amount on which the stamp duty should be calculated. The Crown claimed it on £88,749, which they said was the real purchase money given for the company's concern, whereas the Corporation said that no duty was payable on £37,929, which was part of the larger sum, as it was the price of the personal property sold by the company, and that real property alone was chargeable, with an *ad valorem* duty of 5s. in every £50. The Divisional Court held that the contention of the Commissioners was right, and that the instrument should be stamped with £443 15s. From that decision the Corporation appealed. At the conclusion of the argument, their Lordships dismissed the appeal, with costs.

Trade Announcements. — Messrs. Royles, Limited, notify that from December 1st their business is transferred to Irlam, near Manchester, where they have erected a modern works expressly adapted to the more perfect and expeditious production of their special manufactures.

Mr. G. R. Peers notifies that he is removing to more convenient offices situate at No. 11, Princes Chambers, John Dalton Street, Manchester.

Messrs. Willans & Robinson's office staff at Thames Ditton will be removed to the Rugby works next April.

Water Concession.—A syndicate which owns a concession abroad wants to negotiate with those willing to provide machinery and working capital for utilising the power. See "Official Notices" to-day.

What the British Consuls have to Say.—*Electric Light and Power Plant of Florence.*—Consul-General Percy Chapman, reporting on the industries of the Province of Florence (Italy), gives some interesting particulars concerning the works of the Tuscan Electric Company. He states that the works are built on ground 44 metres long and 31 metres wide, the buildings containing the engine hall, the boiler room, the battery of accumulators, the workshops, the technical offices, &c. The electric current is produced at a tension of 350 volts by two dynamos manufactured by a Nuremberg firm, which have a total power of 1,200 H.P., and by three supplementary dynamos of 300 H.P. in all. The main switchboard was likewise made and mounted by the same firm. The two generators are directly coupled with two horizontal compound condensing steam engines, manufactured by Signor Franco Tosi, of Legnano, of a total power of 100 H.P., making 150 revolutions per minute. There are three tubular boilers, of which one is for reserve, also supplied by Signor Franco Tosi. These boilers supply the steam at a pressure of 10 atmospheres, and have a heating surface of 200 sq. metres each. The water necessary for feeding the boilers is obtained from a well under the engine room. The battery, supplied from Frankfurt, is able to furnish 864 amperes at 350 volts, and to store energy sufficient to supply 5,000 16-C.P. lamps. The works are built to permit of a large increase, so as to be able to feed 45,000 lamps of 16-C.P. lit at the same time, or over 70,000 lamps installed. The current is distributed on the three-wire system.

The Florentine Electric Tramways, Consul-General Percy Chapman states, are worked by the Belgian Tramway Company, of Brussels, and have large works in the Viale Militare. There are four large boilers and three engines directly coupled with dynamos, two of 400 H.P. each and one of 225 H.P. The installation was made on the trolley system by a New York firm. The total length of lines working, or which will soon work, is 125,265 metres, of which 34,000 metres are in the commune of Florence and 91,265 in other communes. When the lines are fully at work 70 cars will be running. Each will carry 38 passengers. When the adoption of electric tramways inside the city of Florence was first discussed by the Communal Council in 1896, Consul-General Chapman remarks, some members did not fail to point out the advisability of discarding the trolley and of adopting some system without overhead wires that would not permanently spoil the city. But the majority, seconded by public opinion, which was anxious to avoid delay, and considering that all other systems were as yet new and liable to further improvement, and also too expensive, approved the immediate working of the tramway by the trolley, reserving to the commune the right (Art. 4 Capitolato) to oblige the company to change the system whenever desired, compensation being provided for the difference of the working expenses and reimbursement to the company of the capital required for the change after deducting the proceeds from the sale of such material as might have become unfit after the change. In fact, a committee, specially appointed, reported on February 12th, 1899, that after the recent installations in Paris, Hanover, Copenhagen, Turin and Rome, no doubts could be entertained as to the practicability and perfect safety of the traction by accumulators, and recommended the adoption of a mixed system of trolley and accumulators, the first outside, 65 kilometres, and the second inside, 7 kilometres, Florence, so that cars provided with both accumulators and trolley would, beyond the boulevards surrounding the city, lift up the trolley, put it in contact with the wire overhead, and proceed outside the city on the old system. The financial question was not, however, thoroughly entered into, but it was stated that the difference in the working expenses with the new system would not be very considerable. On the other hand, the Ingegnere G. Lenci, assessor of public works, was of opinion that the adoption of accummulators would cost 6,000 lire, £240, per car beyond the expense incurred by the trolley. Consul-General Chapman remarks it is now premature to state what decision will be arrived at; but he thinks it may be anticipated that the new system will be found as yet too expensive, and that the tramways of Florence will be carried on for many years to come on the present system.

ELECTRIC LIGHT AND POWER NOTES.

Chepstow.—The Electric Lighting and Power Company has given way to the D.C. on the matter of charges, and the Council has agreed to a maximum of 7d. per B. of T. unit for lighting and 5d. for power. The application to Parliament will therefore have the approval of the D.C.

Adelaide.—The Electric Lighting and Traction Company of Australia have received advice from Australia that a supply of electricity has been commenced from their Adelaide station. The company's stations at Melbourne, Geelong, Adelaide and Port Adelaide are now all in operation, and the supply is being rapidly taken advantage of for lighting and power purposes.

Dorking.—The U.D.C. has resolved that the resolution passed in November, 1900, agreeing to transfer the electric lighting provisional order to a company, be rescinded.

Durham Collieries.—Messrs. Reid, Ferens & Co., electrical engineers of Sunderland and Newcastle, have just completed an installation at Esh New Winning Colliery, Waterhouses, County Durham, for the owners, Messrs. Pease & Partners. The installation consists of two Robey horizontal engines, with cylinders of 15 in. diameter and 30 in. stroke, driving two Reid, Ferens and Co.'s dynamos of 137 amperes 220 volts each. These machines are lighting the colliery above and below ground, there being about 200 lights altogether. In addition to supplying the colliery, they also supply the Esh D.C. with energy for 46 32-c.p. lights; and the Brandon and Byshottles D.C. with energy for 51 32-c.p. lamps. The wires are carried on 30 ft. creosote poles, 50 yds. apart, and the lamps are 100 yds. apart. The colliery is also supplying private consumers in the district with energy for 300 16-c.p. lights., for which they charge 4d. per unit. The Sunderland firm named has also just installed a system of street lighting for the Broompark D.C. at Ushaw Moor. The installation consists of 36 25-c.p. lamps, the energy for which is supplied by a dynamo at New Brancepeth Colliery, owned by Messrs. Cochrane & Co. The cost to the Council is £2 per lamp per year. Aldin Grange and Auton Style are also to be lighted. The whole undertaking is in the hands of the Broom Parish Council, which has spent £900 on the plant.

East Ham.—Owing to the increasing demand for electricity it will be necessary to provide additional machinery in the generating station, and the electrical engineer (Mr. Ullmann) has been directed to prepare plans.

Edinburgh.—A report prepared by the resident electrical engineer shows that the total connection is now 431,016 8-c.p. lamps, and the total horse-power for motors is no less than 8,443. The largest output between May 15th and November 21st was 5,546 kw. Works cost per unit sold, ·561d. Total cost per unit sold, ·866d. The report states that the erection of the new 1,200-h.p. steam dynamo at M'Donald Road station will be completed very shortly, and that there will be ample machinery at the two stations to supply the demand for the winter.

The E.L. Committee has recommended that application be made to the Secretary for Scotland to borrow a further £90,000 for the erection of works. This will make a total of £790,000 for which borrowing powers have been authorised in connection with the electric lighting undertaking.

Gloucester.—The Corporations of Gloucester and Cheltenham have succeeded in excluding their areas from the Bill which is being promoted for the supply of electricity in the Forest of Dean, Stroud Valley, &c.

Grays.—The new electric light and dust destructor works were formally opened at Grays last week. The total cost of the works has been just under £20,000. The installation is capable of supplying 3,000 private lights and 3,000 more for public or private lighting. The charge to private consumers is 7d. per unit for the first hour's use and 4d. afterwards, with 3½d. for power purposes.

Guildford.—The T.C. has appointed a Special Committee to report upon the value of the Electricity Supply Company's undertaking, with a view to its being taken over by the Corporation. The Council has also decided to obtain expert opinion at a cost not exceeding 50 guineas. The capital of the company is over £21,000, and last year there was a deficit on the working.

Hospital Lighting.—The Bolingbroke Hospital, Wandsworth Common, is being electrically lighted throughout, and fitted with a complete system of intercommunication automatic telephones by Messrs. Duncan Watson & Co., who have also secured several similar contracts for important hospitals in and around London.

Hull.—The E.L. Committee has considered a letter from the new manager of Earle's Shipbuilding Yard and Engine Works, asking the Committee to quote the lowest possible price for the supply of electricity for driving the shop machinery and for lighting. It was stated that about 900,000 units per annum would be required. Messrs. Amos & Smith also made application. The electrical engineer recommended that manufacturers consuming not less than 500,000 units a year be charged 1d. per unit, and the Committee agreed.

India.—A provincial town in Bengal, a purely native one—Dacca—is entirely lighted by electricity. The Nawab of Dacca, Sir Ahsanullah, has had an installation laid down, costing nearly four lakhs of rupees, or over £20,000, at his own expense.

Liverpool.—A deputation of tradesmen and residents waited upon the Electric Power and Lighting Committee last week, to request that Renshaw Street, which has just been widened, might be lighted with electricity instead of gas. The Committee decided to recommend to the Council that electricity be used.

Mutford and Lothingland.—The R.D.C. has received a letter from the Lowestoft T.C., stating that the E.L. Committee had resolved that application be made for a license to supply electricity in the rural district; also one from Messrs. Barber & Croft, of Oulton, asking the Council to grant wayleaves to enable them to erect poles and wires to distribute electricity in the rural district. The D.C. resolved to consider the advisability of applying for a prov. order, and replied accordingly.

Ormskirk.—Last week the U.D.C. decided to obtain a report on the establishment of the electric light in the town from Mr. Piers (Manchester), at a fee of 20 guineas.

Otley.—The D.C. has determined to apply to the B. of T. for a prov. order for electric lighting for the district, and Mr. Wilkinson, electrical engineer, of Harrogate, has submitted two schemes to the Council for the supply of energy to 9,000 8-c.p. lamps.

Paisley.—The T.C. has approved of a recommendation by the E.L. Committee to supply the company with the electrical energy required for the working of the tramways.

Pembroke.—The D.C. has decided to make application for a new loan of £20,000 for the purpose of extending the electric lighting facilities.

Pontypool.—At the meeting of the D.C. the E.L. Committee reported on the proposed purchase by the Council of the plant and works of the Pontypool Electric Lighting Company. It was resolved to convene a special meeting for December 9th to consider the matter.

St. Andrews.—The draft agreement between Messrs. Crompton & Co. and the Corporation has received the support of the E.L. Committee. Before coming to a binding arrangement, however, it is thought desirable to get the advice of an expert.

Sale.—Mr. W. C. E. Meade-King has held a L.G.B. inquiry into the application of the U.D.C. for sanction to borrow £8,000 for electric lighting purposes.

Twickenham.—The U.D.C. has approved of the application of the Edmundson's Electricity Corporation for a prov. order for lighting the district.

Walsall.—The Walsall Theatres Company are putting down an electric plant of their own, owing to the Corporation not reducing its charges for the energy used.

Wimbledon.—The electric engineer reports that there are now 30,307 8-c.p. lamps belonging to private consumers, and 4,560 public lamps connected. The E.L. Committee has approved of the draft agreement with regard to lighting the parish of Merton from the Council's mains, which are also to be extended westward to Rayne's Park.

Epsom.—It is proposed to light the Grand Stand at Epsom Race Course with electricity at a cost of about £1,675. This includes cost of 1,000 lamps and a passenger elevator. The Grand Stand Association are willing to pay for the cable from the Council's generating station. When the revenue from private sources along the route amounts to £120 per annum, the Council reserve the right to buy back the cable at £600. The Association also will guarantee to pay a minimum of £25 yearly for current for a period of years to be agreed upon. This and an alternative scheme have been reported upon by Mr. Hawtayne. A schedule of alterations and extensions at the electricity works has been prepared in readiness for an application for an additional loan.

ELECTRIC TRACTION NOTES.

Accrington.—The Accrington Steam Tramways Company have declined the Corporation's offer to treat for the purchase of the Church to Clayton-le-Moors section of their system, with a view to its conversion into an electric tramway. They point out that such a transaction would risk their shareholders' interests, and suggest that as their lines extend into various municipal and district council areas it would be more business-like for the Accrington Corporation and other authorities affected to join in a scheme for acquiring the company's undertaking as a whole. The directors are willing to consider such an offer, but urge that it is unreasonable to expect them to "lop off" portions of their lines for sale to different buyers at different times.

Ayr.—A conference between the Tramways Committee and the representatives of the District Committee was held on the 27th ult. with reference to the proposed extension of the electric tramways to Burns's monument. The construction of the line will be pushed forward in order to be ready for next summer's traffic.

Blackpool.—Although the increase of fares on the promenade section of the Blackpool trams has had the effect af reducing the number of passengers, more money has been earned. At the Town Council meeting on Tuesday it was stated that in 1900 when the 1d. fares were in operation, the passengers numbered 3,345,245, and the receipts were £21,657, during the season—May to September, inclusive. This year the passengers numbered 2,753,29 and the receipts from 2d. fares reached £22,511. It was pointed ou

in regard to the increased tariff, that if the Corporation depended upon Blackpool people alone, they would not be able to run tramcars at all, and ½d. fares would be possible if the summer traffic were maintained all the year round; but as that traffic was only for a short period, the Corporation were bound to make the fares remunerative.

Bingley.—At the last D.C. meeting the Highways Committee reported that a letter had been received from Mr. Quin, of Blackpool, suggesting a scheme for tramways between Shipley and Keighley, passing through Bingley. The Committee replied that they were favourably disposed toward the scheme, and were giving the matter further consideration. Mr. Quin proposes that the local authorities through whose districts the tramways should pass should lay the permanent way, and afterwards let to him for a period the right to run tramcars, supplying him with electrical energy for that purpose.

Bordeaux.—A petition is being signed at the present moment in Bordeaux against the use of the overhead system, and demanding its substitution by the underground, or, adds the petitions, "by compressed air or steam." Several other improvements of a minor nature are requested; such, for instance, as the placing of three hands on each car instead of two, a ticket-issuer, a wattman and a conductor, erection of kiosques, &c.

Brighton.—The Ditchling Road, the Drive and Beaconsfield Villas section of the Corporation electric tramways has been completed, and Colonel Von Donop made an inspection of it on 29th ult.

Burnley.—The new electric cars were run for the first time at midnight on Monday, but a good many townsfolk were present. The electrical engineer, Mr. Birkett, and the tramways manager, Mr. Mozley, were among those present at the trial trip, which passed off successfully.

Cardiff.—A special meeting of the C.C. was held last week to consider a recommendation of the Tramways Committee that the Council make a final offer of £50,000 to the Tramways Company for the whole of their system, exclusive only of the depôts, rolling stock, horses, &c. The Tramways Company offered to sell under these conditions for £54,500. An amendment was moved that the company's offer be accepted, but was withdrawn, and the recommendation of the Tramways Committee was adopted.

Chester.—At a meeting of the Tramways Committee last week, the question of the system of traction to be adopted for the trams which have been acquired by the Corporation was considered. It was decided to recommend the Council to proceed with the overhead trolley system from near the fountain, Bridge-street, to Saltney at the earliest possible opportunity. The system in the principal thoroughfares has not been settled, the committee awaiting the results of experiments being conducted with the surface contact system at Wolverhampton. The Committee recommend the retention of the services of Mr. John Gardner, the present manager of the trams.

Dewsbury.—With the exception of a few holdings, the whole of the shares of the Dewsbury, Batley & Birstall Tramway Company have been bought by the British Electric Traction Company.

Exeter.—The Council has appointed an Electric Traction Committee to consider the question of dealing with the present horse trams (run by a company) and of extending the service to all important routes through the city to the suburbs. The Committee (on November 23rd) considered a letter from Messrs Tahourdins and Hitchcock, solicitors to the Electric Tramways Construction and Maintenance Company, Limited, 34, Victoria Street, Westminster, asking the Corporation's consent to the promotion by the company of a Bill in Parliament authorising them to reconstruct the present short length of tramway and add seven new routes, two of them running to the suburbs of Heavitree and Alphington, outside the city boundaries, the whole to be run by current supplied by the Corporation. The Committee decided to recommend the Council to decline to consent to the proposed Bill, and to oppose it in Parliament if necessary. The Committee next considered a report by Messrs. R. Hammond and A. Dickinson, Westminster, who had been retained to advise the Council on the general question of electric tramways in the City. Eleven specific questions were submitted to the experts, and their replies are summarised below. They advise the Council, as the road authority and owners of the electric light undertaking, to become the owners of the city tramways, and to work the tramways themselves in preference to leasing them, remarking on the improvement in the cost of generation which has been effected in those towns in which electric traction and lighting have been combined. They recommend the alteration and extension of the lines (not, however, to the extent contemplated by the Electric Tramways Construction and Maintenance Company), the total length of tramways recommended by the experts being 11 miles, in approximately 8½ miles of streets as compared with 2½ miles of existing lines in 2¼ miles of streets. The gauge recommended is 3 ft. 6 in., the same as at present, and a continuous current, supplied by a bare overhead feeder at 500 volts pressure, 20 amperes per car being suggested as a basis for the machinery and feeders. The continuous current could be supplied from the new works about to be erected, either converted from the two-phase or supplied by special plant. Messrs. Hammond and Dickinson estimate the total cost of acquiring the present undertaking and equipping it and the suggested new lines at £92,500, or approximately £8,409 per mile. Alternative systems of traction for certain sections of the line would be possible but highly inadvisable. The minimum car-miles run should be 400,000 per annum, and on the low traffic receipt of 9d. per car-mile the total traffic receipts would be £15,000 per annum, and as the working expenses should not exceed 5½d. per car-mile, £5,833 would on this basis be left to pay interest and sinking fund. A special Act of Parliament is recommended as the best method of obtaining powers. Regarding the hotly-debated question whether cars should be allowed to pass along the narrow High Street, Messrs. Hammond and Dickinson are distinctly of opinion that no service of cars can be successful which does not pass through that thoroughfare. Through the narrowest parts they say it would be necessary to lay the line on the double-single method.—The Committee also received a letter from the British Electric Traction Company, Limited (whose purchase of the existing tramways has been sanctioned by the Board of Trade), concerning that company's proposal to apply for powers to construct a 5½-mile line, but resolved that the company be informed that the Committee are not in a position to discuss the question of electric traction with them at present. The Committee also resolved to recommend that a postcard poll be taken of the burgesses, the questions for the voters' consideration being—(1) Should electric tramways connecting the various parts of the city be established? and (2) if such tramways be adopted, should they be laid through High Street, Queen Street, and Fore Street?

The City Council on Wednesday evening considered the Committee's report. Councillor Perry, in moving its adoption, said the Council would have the option of acquiring the present tramway system next July. The notification of the intention of the Electric Tramways Construction and Maintenance Company to apply for Parliamentary powers had come as a thunderbolt to the Council. Councillor Ross, in seconding, thought the experts' estimate of the mileage cost (about £8,000) was extraordinarily low, compared with such places as Taunton and Plymouth, where the cost had been £12,000, and Nottingham, where the cost had been between £14,000 and £15,000. He had, further, never heard of working expenses being less than 6½d. or 7d. per car-mile.

Italy.—The Mediterranean Railway Company has just completed the first section of the lines it proposes in future to work electrically—that from Milan (Gallarate) to Pato (Ceresio). Next year the installation of the Gallarate-Loreno and Gallarate-Harona sections will be carried out. The total length of the lines to be worked electrically is 130 kilometres.

Leeds.—The Corporation will watch with interest the proposed street cleansing by electricity at Nottingham. If the experiment should reveal any new instrument of real usefulness, the Lighting Committee will not delay in taking advantage of Nottingham's experience. The tramways department already own an electric snow sweeper, which is capable of clearing 4 miles of snow-covered track per hour. It has also an electric watering machine, with a capacity for pulling over 2,000 gallons of water on the tramlines.

Mr. W. L. Jackson, M.P., chairman of the Great Northern Railway Company, speaking at the annual dinner of the members of the Association of the Leather Trade of Leeds and district last week, said: "There is a great change coming over the railways. One cannot say whether we are going to continue to haul our trains by steam locomotives, or whether we shall have to face an enormous outlay on electric motors. Nobody can question what a convenient method locomotion by electricity is, and it will be a most serious competitor. It may not come in my time, but I believe that, certainly as regards passenger work, you will see electricity as the motive power on many of the great branch and suburban lines of the country."

Wolverhampton.—Our local correspondent writes as follows:—"Considerable surprise and no little indignation is being expressed that the Lorain Company have not yet completed the 'experimental line' on the Bilston road, whereon a test is to be made of their surface contact system of electric traction prior to its general adoption—or rejection—by the Town Council. Alderman Mander, chairman of the Tramways Committee of the Town Council, stated at the September meeting of that body that the contracts entered into with the Lorain Steel Company, Limited, provided for a certain portion of the electric tramways to be running by the end of October—the exact date he mentioned was three months from July 26th. The first portion to be completed was, as was stipulated, an 'experimental mile.' On this mile a 30 days' test of the new system is to be made, and if successful the system is then to be extended to the other lines, several of which have been constructed and partly equipped in readiness. We are now, however, in the month of December—six weeks beyond the time mentioned by Alderman Mander—and yet there is no sign of the test being applied. The line, it is true, is nearly finished, but its equipment is far behind. This is creating great dissatisfaction."

Liverpool.—At a recent meeting of the Tramways Committee, a motion by Mr. F. Saunby in favour of universal penny fares, dating from January 1st, 1902, was defeated by seven votes to two.

Manchester.—The Electricity Committee have decided that they will be able by the end of May to undertake the supply of the electric current for the Hyde Road and Stockport Road tramway routes. Other routes will be supplied afterwards.

Wimbledon.—The U.D.C. have appointed a Special Committee to report upon the preliminary notices for tramway schemes affecting Wimbledon.

(*Continued on page* 937.)

THE CENTRAL EXCHANGE OF THE LONDON POST OFFICE TELEPHONES.

The approaching completion of the huge undertaking upon which the engineering staff of the Post Office has been busily engaged during the last two years, and the recent promulgation of the tariff which is to be put in force, have attracted so much attention, that a brief account of the work which has been accomplished will probably be of interest to our readers. We say *brief* advisedly; for a full technical description and explanation of the complex arrangements rendered necessary by the magnitude of the task, and the peculiar conditions involved, would fill our available space for many weeks.

Chief Testing Officer's Desk.

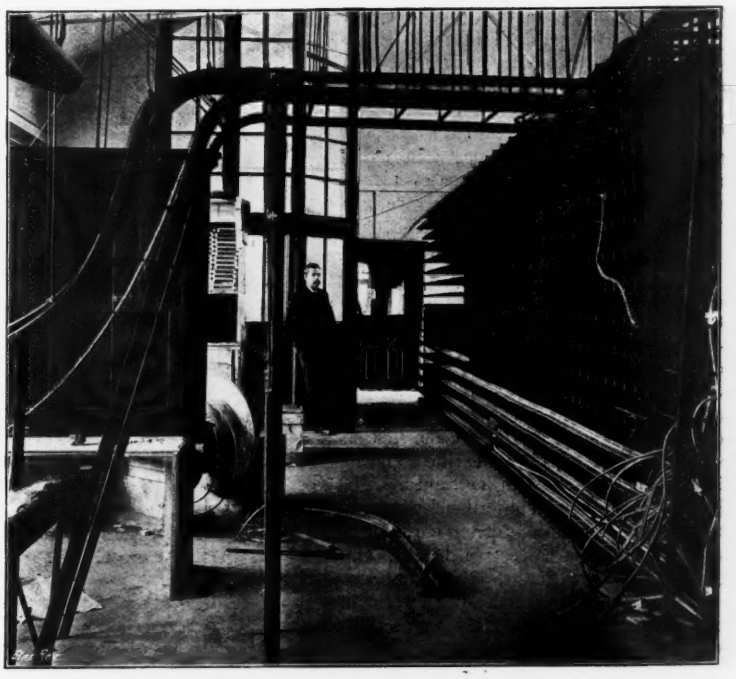
The main features of the new service are as follows:—The adoption of the Western Electric "common battery" system; the use of underground conductors; provision for a toll rate of charging; intercommunication with the trunk lines to provincial towns, with other Post Office exchanges operated on the permanent current system, and with the National Telephone Company's system; and various minor advantages, incidental to the use of the common battery system, such as the automatic signalling of calls, clears, and faults, &c.

The Central Exchange, which is the first to be taken in hand, is situated in the Savings Bank Buildings, Queen Victoria Street, and is designed for an ultimate capacity of 14,400 subscribers; it will therefore eventually be one of the largest exchanges in existence. The present accommodation provides for 5,400 subscribers. Ample provision is also made for junctions and trunk lines, which will be referred to later.

The telephone department is lodged partly in the basement and sub-basement of the building, and partly on the top floor; at present only a portion of the space available is utilised.

The main cables enter the building through tunnels excavated towards Queen Victoria Street on the south side, and Carter Lane on the north. In these tunnels were laid literally hundreds of ducts, consisting of polygonal tubes of earthenware, bedded in cement. Eleven layers of these, with 10 in each layer—110 in all, run to an underground chamber in Queen Victoria Street, while 95 ducts lead to Carter Lane. Each duct is intended to receive a lead-covered cable of 434 conductors, insulated with paper and air space; the conductors are of No. 20 S.W.G., and are stranded in pairs to prevent inductive disturbances and "cross-talk," if not cross talking! These cables were wholly supplied by companies established and working in this country. Their cost amounted to from £950 to £1,000 per mile. We shall deal with the outside work in a later portion of this article.

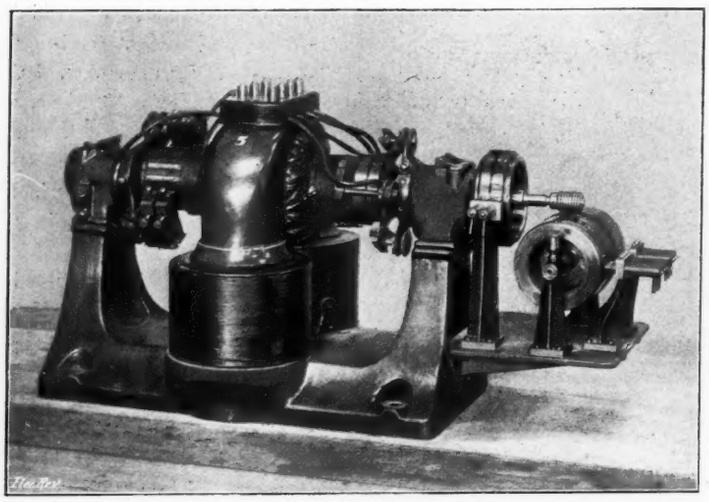
The sub-basement was excavated beneath the original basement for the reception of the cables, and is furnished with vertical racks, carrying horizontal angle irons, which provide a seating for blocks of "battery slate," 9 in. square and 1 in. thick; these are laid at intervals of about 9 in., so as to form ventilated shelves upon which the cables are laid in regular order. Each shelf accommodates three cables, side by side. Thus all the cables are visible and accessible throughout their whole length in the sub-base-



Horizontal Side of Intermediate Distributing Frame
(The cable rack and the back of the fuseboard are also shown in this view.)

ment, and the intervention of the slates prevents electrolytic corrosion of the iron frames due to contact with the lead sheathing.

The cables are brought along the shelves to the west end of the room, where they terminate. They are too unwieldy to be carried further, so at this point smaller cables, each containing 217 pairs of silk-covered wires, of No. 22 S.W.G., are joined up to them. The joint is made in the usual way, each joint in the conductors being soldered and covered with a paper sleeve, after which a large leaden sleeve, which has been slipped over the cable beforehand, is drawn over the bunch, and a wiped joint is made at each end of the sleeve with the lead sheaths of the two cables. Finally, a composition of castor oil and resin is pumped into the sleeve through a brass nozzle, which is then closed with a screwed cap.



Motor-Alternator for Ringing, and Tone-Signal Drums.

The cables, thus reduced in bulk and weight, pass on upwards into the basement proper; in doing so, in order to avoid crossing one another, they are turned completely over, remaining, however, in the same order as in the sub-basement. The basement is fitted along one side with a large iron frame in the form of a rack; this is provided with horizontal terminal blocks on one side, and with vertical ones on the other. The incoming cables are led along the rack, each of them ending at a suitable point near one of the horizontal terminal blocks, which are arranged according to a code, so that any cable can be at once identified, and its destination known with certainty. The individual pairs of subscribers' wires are brought in systematic order to consecutive terminals on the respective blocks, and terminate upon them.

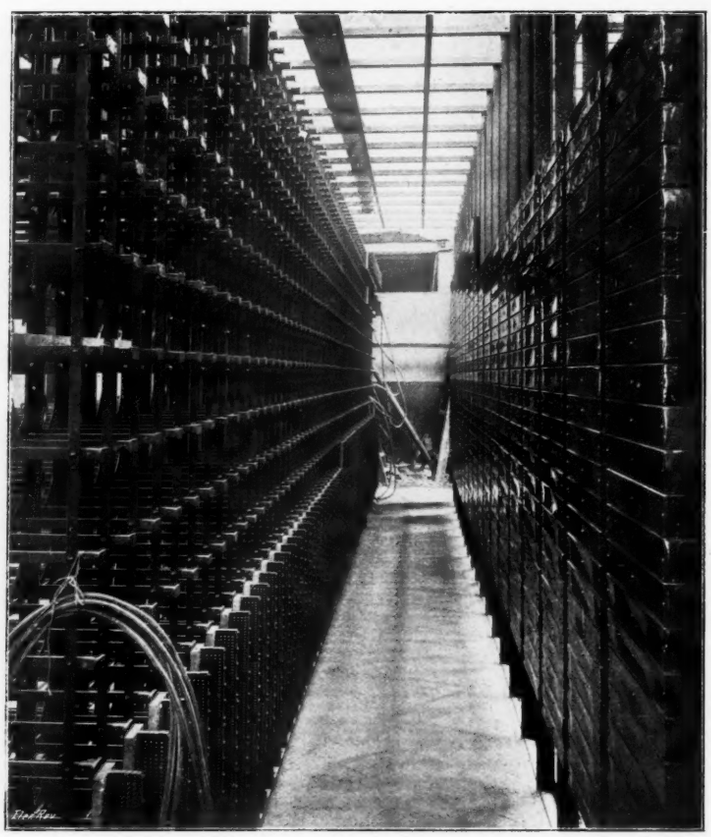
As may be supposed, the work of codifying and arranging the connections at this point is a matter of no small difficulty and importance; it is simplified as far as possible by the use of distinctive colours for the paper coverings of the wires, but this alone is insufficient for the purpose. However, the problem has been solved, and no confusion can possibly arise between the various circuits.

On the other side of the rack are the vertical blocks, each fitted with 100 sets of terminals, numbered consecutively. A cable containing 102 pairs of wires, of which two pairs are spare, is connected up to the terminals, and runs from the basement to the intermediate distributing frame on the top floor.

Now, on the horizontal side of the main frame, the subscribers' wires are arranged purely with regard to the respective cables of which they happen to be constituents; consequently their *numbers* in relation to the apparatus, are, on this side, in a state of chaos. On the vertical side they must be in perfect order. To effect a transformation is the function of the distributing frame. No matter where, for example, No. 1,001 may happen to terminate on the horizontal side, his pair must be connected with the terminals marked 1,001 on the vertical side. For this purpose a pair of wires, called "jumper leads," are soldered to the incoming terminals, led along the frame to a point opposite the appropriate vertical board, then across the frame, through an insulated ring, and up or down to the required terminals on the vertical board. Thus chaos is reduced to order.

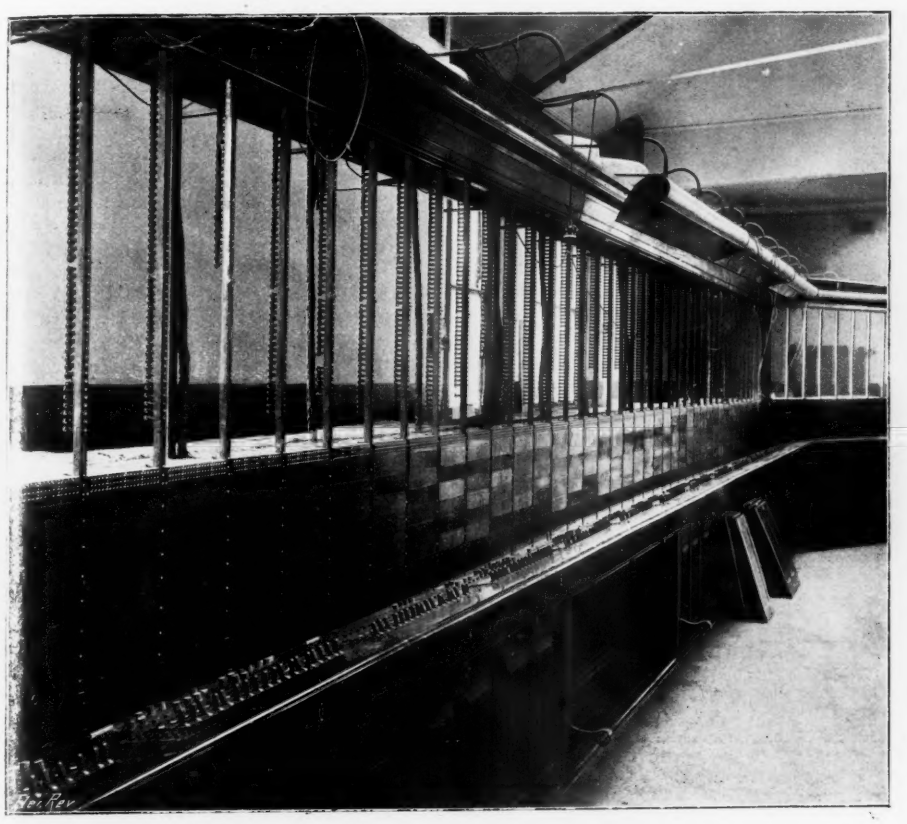
It is obvious that, thanks to this arrangement, a subscriber's number need not be changed in the event of his removal from one house or street to another; so long as he remains within the area controlled by the exchange, he may carry his number with him, the necessary correction being made on the main distributing frame.

In addition to the functions already explained, the vertical boards provide accommodation also for the heat coils and lightning arresters. These are clipped on the terminals, one on each pole of the circuit. Further, by the removal of the heat coils and the insertion of a plug, a subscriber's circuit may be divided at this point into two parts, one external to the exchange, the other inside it; a flexible cord connected with the plug extends both sections to the chief



Vertical Side of Intermediate Distributing Frame, and Front of Relay Rack.

testing officer's desk, which is located in the same room, and is fully equipped with means for carrying out all manner of tests on the condition of the lines, position of faults, &c.



Front View of Part of Subscribers' (Local) Board, in Course of Construction.

The testing desk is shown in one of our illustrations, but the system of connections which it encloses is so complex that we do not propose to explain it in detail.

The cables passing between the top floor and the basement are carried up a disused lift-shaft, the lift having been removed to leave it available. They are supported by horizontal cast-iron frames in an ingenious and simple manner; a piece of glass-paper is wrapped round the lead sheathing, and a split circular wedge is driven in between this and the iron frame. The supports are situated at intervals of about 12 ft.

The remaining equipment of the basement consists of the batteries and main switchboard, charging and ringing machines, and the repeating coil racks.

Two main batteries are provided, to ensure against breakdown. Each of them consists of 11 Chloride cells, with 33 plates, in leaden tanks. The latter are large enough to accommodate 65 plates eventually. The present capacity is 2,000 ampere-hours at 250 amperes discharge; the final capacity will be 4,400 ampere-hours. Each cell contains nearly 8 carboys of dilute acid, and when completely equipped with plates, will weigh 2 tons. The leaden tanks are $\frac{1}{4}$ in. thick, and are reinforced by wood battens at each side. They are carried on a wood base board supported by glass insulators, on wooden frames laid on the concrete floor.

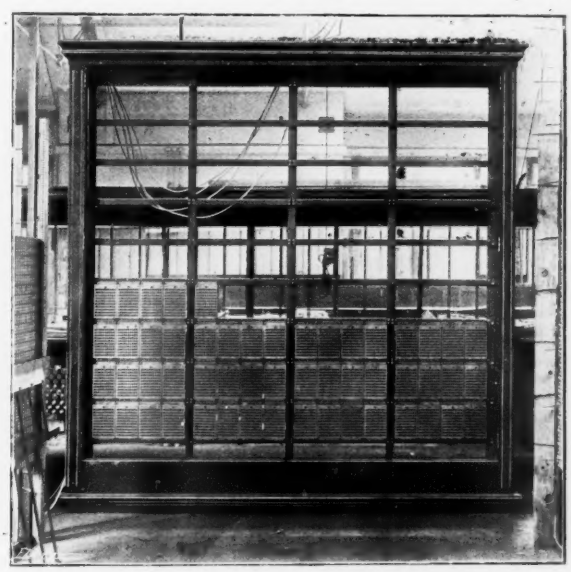
The batteries are housed in a separate chamber, cut off from the main room by a glazed partition.

For reasons which will appear later, it is a prime essential to the success of the common battery system that the resistance of the battery shall be very low; hence the large size of the cells and of the main leads. The latter consist of two 91/12 cables in parallel on each pole, giving a cross-sectional area of 1·53 sq. in. The positive pole is earthed by means of a No. 0 S.W.G. copper wire, connected with the cylinder of the hydraulic lift, which extends to a depth of about 40 ft. into the earth.

Each cell is provided with a separate lead to a voltmeter switch on the main switchboard, so that the electrical condition of the batteries can readily be tested from that point. Further, a No. 0 wire is joined to each battery between the second and third cells from the positive (earthed) pole, for the line relays.

The charging plant consists of two similar motor-generators of the Western Electric Company's make. Each of the motors is of 25 H.P., and drives the generator at 650 revolutions per minute through an insulating coupling. Both motors and generators are of the four-pole shunt-wound type; the motors are run off the electric lighting mains at 102 volts, or off a dynamo driven by a gas engine, which is to be installed as a reserve. The generators are rated at 500 amperes, 20 to 30 volts, and have specially large commutators; the latter are built of many segments, and multiple copper gauze brushes are used, it being claimed for this construction that if necessary the service could be carried on direct from the generator, without annoyance due to the humming caused by commutation.

The ringing apparatus consists of two small two-pole machines, of which we give an illustration. Each of these is a motor-alternator, one being designed for a supply pressure of 24 volts for running off the battery, and the other for 102 volts for running off the electric light mains. The armatures are double wound, the generator side being

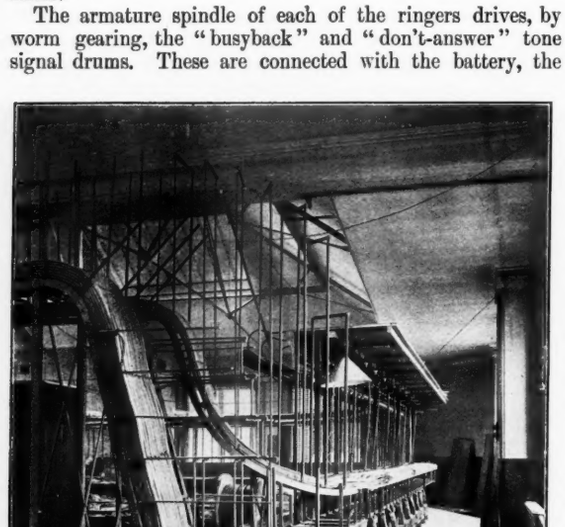


Resistance Lamp Rack.

connected to slip rings, so as to give an alternating current at 75 volts for ringing magneto bells. The field magnets are differentially compound-wound, and a choking coil is inserted

in the leads from the battery, to prevent disturbance of the latter.

The armature spindle of each of the ringers drives, by worm gearing, the "busyback" and "don't-answer" tone signal drums. These are connected with the battery, the



Cable Racks, and Back View of Local Board under Construction.

current passing through an interrupter on the armature spindle, and then through the slow-running drums. The latter cause signals to be sent intermittently once in two seconds; the interruptions produce a humming sound in the telephone receivers, which is split up by the "busyback" into regular beats, thus — — — — — and by the "don't-answer" into beats thus - — - — - — - — so that the signals are clearly distinguishable from one another. Their use will be explained later on.

The main switchboard consists of three panels of slate, allotted to the motors, generators, and batteries respectively. On the motor panel a double-pole, double-break throw-over switch is provided, to couple the motors with either the electric light plant or the reserve plant. Each motor has a separate 250-ampere d.p. double-break switch and fuses, as well as a Cutler-Hammer starter. The small ringing motor-generators have similar provision, but for 25 amperes and 6 amperes respectively. On this panel are also two voltmeters, one reading 0—50 volts, and the other 0—3 volts for testing individual cells, with an 11-point voltmeter switch.

The generator panel carries two heavy d.p. double-break 600-ampere charging switches, and an automatic overload and reverse current safety cut-out common to both. The latter is operated through a polarised relay, and cuts out with certainty when the current falls to zero. There are two ammeters, reading 0—300 and 750—0—750, the former having a switch by means of which it may be connected with shunts in various circuits. The generator pressure is regulated by Ward-Leonard rheostats. Throw-over switches for the tone signals are also provided on this panel, as well as for the battery voltmeter.

The battery panel is fitted with a very heavy throw-over double-break switch for charging, and a massive d.p. double-break throw-over switch for substituting one battery for the other without affecting the working of the exchange. This is done by putting the two batteries in parallel for a moment in the act of switching over, a resistance contact being provided to prevent an excessive flow of current in the event of the pressures being materially unequal. Fuses are also provided on this panel.

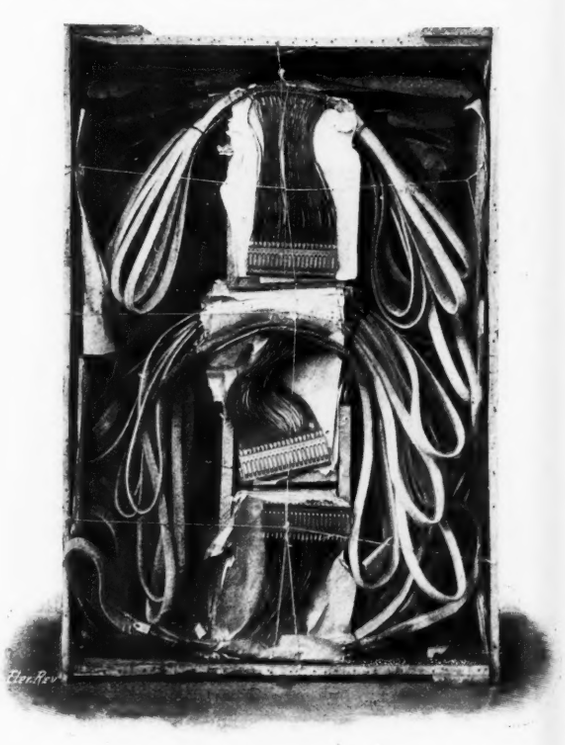
The measuring instruments are all of the Weston type, and knife switches are used throughout.

There remains the repeating-coil rack, which is placed near the battery in order to minimise the resistance in the common battery circuit. This rack carries all the repeating coils, which are interpolated in the "cord circuits" to be described later; there is also a fuseboard, on which is a fuse for each coil, on the negative pole; those on the positive pole, which is earthed, require no fuses. The cables from the operators' keyboards to the repeating coils and back again are lead-covered, like the others already mentioned, and are taken through the same shaft.

We turn now to the equipment of the "operating theatre." This is situated on the top floor, and is well lighted from the roof, this being, of course, the main reason for the predilection always shown by telephonists for upper storeys. The centre of the room is occupied by the "junction board"; starting opposite one end of this, the "local board" runs round two sides of the room at present, roughly forming, with the junction board, the letter **U**. When the exchange reaches its full capacity, the local board will extend round three sides of the room. The supervisor's desk is in the centre of the room, at the open end of the **U**.

Behind the junction board are the racks for relays, meters and resistance lamps, and the intermediate distributing frame, while a large fuseboard is fixed opposite the first end of the local board. A private office for the engineering staff is partitioned off near the door, opposite the intermediate frame.

The latter is shown in one of our views, and is a very important and useful apparatus. In general, it is like the main distributing frame in the basement, but in this case, the connections on the *horizontal* side are all in numerical order, while those on the vertical side may or may not be in order. The horizontal side is provided with iron brackets, to which are screwed wooden slips, each 6½ in. long and about ½ in. deep. Each of these slips carries 80 terminals on the upper side, and provides for 20 circuits. The terminals consist of simple strips of brass embedded in ebonite,



Strips of Jacks Connected with Cables, as Received at Central Exchange.

and the connections are made by soldering. The cables from the main distributing frame are brought overhead from the cable shaft through the wall of the room, being supported by iron frames, and are distributed to the terminals on the

horizontal side of the intermediate frame; as each cable contains 102 pairs, it requires five terminal strips. There are, therefore, for 5,400 subscribers, 54 cables and 270 strips. No less than 260 wires end on each terminal strip, so that in all there are over 70,000 joints on this side only of this frame.

The terminals on the vertical side of the frame belong to the leads from the subscribers' "local sections," *i.e.*, the jacks upon which all *calls* are received. They are connected with the terminals on the horizontal side by "jumper leads," in exactly the same manner as in the case of the main distributing frame. In the first instance the local section jacks will be connected in numerical order; 180 are allotted to each operator's position. Now, as time goes on, it will be found that some operators are kept too busy, while others are slack; in order to apportion a fair amount of work to each operator, it will be necessary to transfer some of the busier subscribers from the overworked operators to the leisured ones, and to replace them by subscribers whose calls are few. This will easily be accomplished at the intermediate frame, by crossing the jumper leads, without in any way interfering with the local section jacks themselves or with the operator's duties.

Behind the intermediate frame is the relay rack, of which we give a view; and behind this again is the meter rack. The connections to all this apparatus are taken from the horizontal side of the intermediate distributing frame, and are therefore quite unaffected by any change in the arrangements of the jumper leads. The relays and meters are arranged in blocks of 10. The resistance-lamp rack is immediately behind the junction board, and is arranged in blocks of 101 lamps.

The local board is divided into 10 sections of nine panels each, and 30 operators' positions. The subscribers' jacks, from 0 to 5,400, are multipled—*i.e.*, repeated—in each of these sections, and are connected to the horizontal side of the intermediate frame, so that they are permanently arranged in numerical order. They are mounted in strips of 20 (0—19, 20—39, &c.) measuring $7\frac{3}{4}$ in. wide × $\frac{3}{8}$ in. deep; three vertical lines divide the strips, at every fifth jack, and horizontal lines separate blocks of 100 (0—99, &c.) from one another. Each block is numbered from left to right in the ordinary way; the first 9 blocks run right across a section (nine panels), after which the second 900 start again at the left hand side, above the former. Thus no difficulty will be met with in adding jacks up to the full capacity of the exchange, and although the system seems rather confusing, it is readily mastered by the operators, who hardly need to read the numbers, so skilled do they become.

Below the multiples come the "outgoing junctions," of which there are 240; these are exactly similar to the subscribers' jacks, but are multipled every *six* panels instead of nine, there being 40 per panel. Next are the local sections; these consist of jacks and call-signal lamps, mounted in strips of 10, the 10 jacks taking up $7\frac{3}{4}$ in. × $\frac{3}{8}$ in., and the 10 lamps $7\frac{3}{4}$ in. × $\frac{7}{16}$ in. As already mentioned, there are 180 local jacks per panel, and these are not multipled.

Space is provided for a total of 14,400 subscribers, and 1,800 outgoing junctions; also 60 local jacks can be added at each position, so that on this basis 60 operators will be required for the full capacity of the exchange.

An extra $\frac{1}{3}$-section is added at the commencing end of the subscribers' board, and a similar extra third at the beginning of the junction board, because, otherwise, the end operator could not conveniently reach the whole of a section.

On the keyboard at the foot of the vertical panels there are 17 pairs of cords and plugs for each operator, 17 pairs of clearing lamps, 17 meter keys, 17 speaking and ringing keys, and an extra ringing key for the call wires; there is also a panel of 12 order wire keys for the call wires, which are multipled at every position.

The junction board consists of nine positions, *i.e.*, 27 panels, plus the extra three panels already mentioned. Six positions are allotted to incoming junctions from other central battery exchanges; two to Post Office permanent current exchanges, and one to trunk-line service.

On this board the subscribers' multiples are arranged as on the local board.

Above the multiples are 240 outgoing junction jacks, multipled every six panels. These belong to exchanges which have not a full set of junctions to other exchanges, and therefore have to communicate with them *viâ* the central exchange.

Below the multiples is a row of 10 jacks; five of these are for the "busyback" signal, and five for the "don't answer" signal.

A "pilot" lamp is provided at each position; this is for use when a reduced staff of operators is at work, and is employed at night in conjunction with a bell. The latter draws attention to the call over a call wire, and the lamp, lighting up, indicates the position where the call occurs.

There are 28 junctions at each position, each provided with a cord and plug, and on the keyboard there are also 28 speaking keys, 28 ringing keys, with electrical restoring device, and a resetting key for cutting off the signal bell and lamp just mentioned. There is one clearing lamp in circuit with each plug. A grouping key on each keyboard provides for grouping any number of positions together when desired, and there is a block of 15 order wire keys at each position.

(*To be continued.*)

ELECTRIC TRACTION NOTES.

(*Continued from page* 932.)

Nottingham.—The Council on Monday considered a report as to the proposed light railways in the city. Sir James Mackenzie's project, of which public notice had been given, was to provide light railways connecting the city electric tramways with Hucknall Torkard, Arnold and Carlton, and with the systems of tramways at Derby and Ilkeston. Sir Bache Cunard's project was to construct light railways on a similar gauge connecting the city tramways with Alfreton, Derby, Hucknall Torkard and Arnold. The report on the two schemes, together with the correspondence, was referred to the General Purposes Committee.

Surrey.—The *Richmond and Twickenham Times* gives prominence to a statement that the L.U.T. Company and British Electric Traction Company have come to an agreement with regard to the division of the County of Surrey into "spheres of influence," within which each proposes to promote tramway schemes. Broadly speaking, the L.U.T. Company will seek to develop the district between the Thames and Wimbledon, Sutton, and Leatherhead, while the B.E.T. Company, starting from Croydon, will confine its portion to the "hinterland" of the county. The B.E.T. Company have undertaken not to intrude westward of the line passing through Wimbledon, Malden, Ewell and Epsom.

West Bromwich.—The E.L. Committee have instructed the electrical engineer to prepare plans and specifications for the extensions of the plant necessary at the Corporation's electricity works, in order to supply the power required for running the trams. Mr. R. C. Quin has been appointed consulting engineer in the matter.

Woolwich.—Much regret is expressed locally at the withdrawal of the L.C.C. scheme for an electric tramway from New Cross to Eltham, on account of the authorities at Deptford and Lewisham declining to contribute towards the cost of the necessary road widenings.

TELEGRAPH AND TELEPHONE NOTES.

Cape to Cairo Telegraph.—We make the following extracts from the report of the British South Africa Company:—

"On January 1st, 1901, the rate for cablegrams between Southern Rhodesia and Europe was reduced from 4s. 2d. to 3s. 8d. a word. The rate for inland telegrams had been previously reduced to 2d. per word, with a minimum charge of 2s. for 12 words, on November 1st, 1899.

"The telegraph system has shown rapid expansion during the past two years, the lines under the control of the Postmaster-General now extending from Mafeking to Lake Tanganyika, a distance of 2,031 miles. At March 31st, 1901, there were 81 offices open, including those belonging to the African Trans-Continental Telegraph Company, Limited. At that date the Rhodesia telegraph system consisted of 3,554 miles of line, with 5,214½ miles of wire.

"The agreement with the Eastern Telegraph Company, Limited, and the Eastern and South African Telegraph Company, Limited, for the provision of additional cable communication between the United Kingdom and South Africa has been signed.

"The construction of the African Trans-Continental telegraph line has been steadily pushed forward in spite of transport difficulties. It has now been carried for a considerable distance along the eastern shore of Lake Tanganyika. The branch line from Domira Bay to Fort Jameson has been completed, and the total length of line constructed at March 31st last was 1,308 miles.

"Since the line crossed the Anglo-German frontier, the German officials have rendered valuable assistance, and have supplied most of the labour necessary for construction.

"The traffic receipts for the year 1900 amounted to £3,188, a decrease of £159 as compared with the previous year. The revenue obtained from the internal traffic increased by nearly 30 per cent., and from the traffic passing between A.T.T. offices and Portuguese East Africa, by nearly 150 per cent., but, owing to the interruption of traffic between Southern Rhodesia and the Cape Colony, the amounts paid to the British South Africa Company and the cable companies show a decrease of £495.

"A service of silver plate was presented by the company in June, 1901, to Sir Somerset R. French, K.C.M.G., Postmaster-General for the Colony of the Cape of Good Hope, in recognition of the valuable services rendered by him in connection with the Rhodesian postal and telegraph system."

The Berlin correspondent of the *Times* says that the semi-official organs state that the Cape to Cairo line of the African Trans-Continental Telegraph Company has now been constructed as far as Bismarckburg, and that it is ultimately intended to connect the German East African line with it at Ujiji.

International Telephones.—A vote of 51,000 lire has just been made for the construction of an international telephone line between Italy and Switzerland. This line will follow in Italy the Milan—Como—Chiasso route, and will be joined to the line at present in course of construction between Chiasso and Zurich. A vote of 700,000 lire has been apportioned for the construction of the international line between France and Italy, which will give a connection between Rome and Paris, following in Italy the route: Rome, Acquapendente, Siena, Firenza, Bologna, Piacenza, Voghera, Vercelli and Turin, to Mont Cenis, with branches from Voghera to Genoa and Milan. The wires will be of silicium bronze, and the line will be laid as far as the French frontier before the bad season sets in. If the winter is not too severe, the works will be continued on the mountain, and the two lines should in this case be finished early next year.

New American Cable.—The *Times* says that the cable steamer *Faraday* on Saturday last finished laying a cable between the Azores Islands and Ireland for the Commercial Cable Company. This completes the fourth cable of that company between the United States and England.

Richmond (Surrey) Telephones.—The Postmaster-General has acquired premises adjacent to the existing Post Office, wherein it is proposed to instal a telephone exchange. It is expected that the service will be available next April.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Para-Maranham	March 1, 1900 ..	..
Landlines:—		
"Via Hanekin" on Persian territory	Feb. 24, 1900 ..	..
Pekin-Kalgan	June 14, 1900 ..	Nov. 27.
Maimatchin-Kalgan	June 30, 1900 ..	Nov. 27.
Communication with Baranquilla and Cartagena	Dec. 8, 1900 ..	..
" towns of Venezuela ..	Oct. 31, 1900 ..	..

Wireless Telegraphy.—Satisfied with the utility and success of the Marconi wireless-telegraph installation of the cross-Channel steamer *Clementine*, the Belgian States Government has decided to fit apparatus to all its passenger boats.

CONTRACTS OPEN AND CLOSED.

OPEN.

Amsterdam.—December 18th. Tenders are invited by the Netherlands Ministry of the Colonies for the supply of telegraphic apparatus.

Birkenhead.—The Corporation Tramways Committee invite tenders for a supply of the following stores for the 12 months ending December 31st, 1902:—Poplar wood blocks; cast-iron brake blocks and other castings; motor grease; river sand; cleaning cloths; sponge cloths and brushes.

Brussels.—December 11th. An adjudication will take place on this date at the Bourse of Commerce (salle de l'Union Syndicate), Brussels, for supply of sundry requisites for the use of the telegraph service in 25 lots, viz.—1st lot, galvanised iron wire (caution 1,180 fr.); 2nd lot, cables (1,370 fr.); 3rd lot, copper wire (210 fr.); 4th lot, copper wire insulated (5,020 fr.); 5th lot, pliable wire (50 fr.); 6th lot, irons and rods (290 fr.); 7th to 12th lots, ironwork (2,170 fr., 1,700 fr, 2,030 fr., 2,030 fr., 370 fr. and 280 fr.); 13th lot, galvanised steel receivers (2,510 fr.); 14th to 19th lots, isolators (14th and 15th lots, 620 fr. each, 16th lot, 400 fr., 17th and 18th lot, 1,520 fr. each, 19th lot, 130 fr.); 20th to 24th lot, telephonic and telegraphic apparatus (20th lot, 720 fr., 21st lot, 100 fr., 22nd lot, 1,080 fr., 23rd lot, 360 fr., 24th lot, 300 fr.); 25th lot, nuts, supports, screws, &c. (190 fr.).

Burnley.—December 12th. Electric lighting plant, battery, switchboard, wiring and mains, steam pumps, piping, &c., for the electric lighting of the Union Workhouse. See "Official Notices" November 22nd.

East Ham.—December 9th. Wiring the new municipal buildings. See "Official Notices" November 29th.

France.—December 16th. Estimates will be opened at the Hotel de Ville, Surisnes, France, on 16th prox., for the supply of three electric units and pumps, for the purpose of raising water in the departmental drainage station; and at the Hotel de Ville, Courbevoie, France, on same date, supply of two electric groups and pumps for same purpose. Information in each case from the municipality.

France.—December 17th. Tenders are being invited until the 17th inst., by the French Post and Telegraph authorities in Paris, for the supply of 15 kilometres of iron pipes for pneumatic pipe lines. Tenders are to be sent to Le Sous Secretariat d'Etat des Postes et des Telegraphs, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Hornsey.—January 15th. Pipework and mechanical coal-handling plant for electricity works for the U.D.C. See "Official Notices" to-day.

Horsham.—December 17th. Meters (D.C.) and cut-outs for the electricity works. See "Official Notices" to-day.

Huddersfield.—December 9th. Engine, 750-kw. generator, boosters, boiler, piping, stoker and conveyer, economiser, switchboard, line equipment, cables and conduits, car bodies, trucks and equipments for the Corporation traction scheme. See "Official Notices" November 22nd.

Leith.—December 16th. Boilers and economiser, condenser, cooling tower, pipes, dynamo and feeder panels. See "Official Notices" to-day.

London.—December 12th. Electric wiring, &c., of Bishopsgate, Brompton and Manchester Square fire brigade stations for the L.C.C. See "Official Notices" November 22nd.

London.—December 19th. Electric fire alarm system for the N.W. Fever Hospital, Hampstead, for the Metropolitan Asylums Board. See "Official Notices" November 29th.

Maidenhead.—December 13th. Steam piping, transformers, motor-generators, battery, switchboard, arc lamps, cable work, and crane for electric lighting works. See "Official Notices" November 22nd.

Maidenhead.—December 13th. Stoneware conduits for electric mains, arc lamp-posts, &c., for T.C. Consulting engineers' Burstall & Monkhouse.

Maidstone.—December 19th. Electric light fitting and wiring at various public buildings for the Corporation. See "Official Notices" to-day.

North-Eastern Railway.—December 9th. Tenders for telegraph stores for six months (1) Telegraph apparatus; (2) Telegraph wire and line stores. Forms of tender, &c., from Mr. Graves Telegraph Department, York.

Nantwich.—January 6th. Water-tube and Lancashire boilers, c.c. steam dynamos, pumps and piping, switchboard, mains posts, battery, meters, crane and dust destructor for the U.D.C. See "Official Notices" November 22nd.

Oban.—December 18th. Three 60-kw. steam dynamos, two water-tube boilers, economiser, &c., for electric lighting. See "Official Notices" November 29th.

Pontypridd.—December 14th. Water-tube boilers, stokers, economisers, steam engines, dynamos, balancer, switchboard, workshop, crane and arc lamps, for electric power station. See "Official Notices" November 22nd.

Reading.—December 28th. Water-tube boilers, economiser, pumps, engines, condensing plant, generators, switchboard, crane, motors and car equipments, car bodies, trolleys, &c., for the Corporation. Borough engineer's office, Town Hall. Specifications, &c. (10 guineas).

Southampton.—December 14th. Electrical equipment of printing and other machines in the Ordnance Survey Office Southampton. See "Official Notices" November 22nd.

Spain.—December 9th. The Municipality of Plencia (Biscay), Spain, will on this date consider tenders for the electric lighting of the town from 1902 till 1908. Particulars from the Secretary.

Sunderland.—December 20th. Cast-iron pipes and copper piping, valves, &c., for electric light station. See "Official Notices" to-day.

Wolverhampton.—December 20th. Two-phase motor-generators, boosters, switchboards, and battery, for Midland Electric Corporation. See "Official Notices" to-day.

CLOSED.

Aberdeen.—Messrs. Macartney, McElroy & Co. are to carry out certain track work, overhead wire construction, &c., for the Corporation, for the Union Street and Holborn Street lines at about £3,834. A new car depôt is to be erected at Mannofield.

Leeds.—Tenders amounting to £13,815 have been provisionally accepted by the Corporation Lighting Committee for works in connection with electric lighting mains. This is exclusive of the tender for the supply of 60 standards for electric arc lamps at £7 19s. 6d. each.

London.—The following tenders were submitted for supplying and fixing power distributing mains, electric lighting installation, and system of inter-communicating telephones at the new printing works of the Celvicol Company, Limited, 76, Southwark Street, S.E., to the specifications of Mr. B. H. Jenkinson, consulting engineer:—

Cecil Cooper & Co...	..	..	£508 13 0
Drake & Gorham ..	..	..	456 10 0
W. Heath	..	..	423 0 0
F. Hooydonk & Co...	..	..	418 8 0
F. A. Glover & Co. ..	..	(Accepted)	411 0 0

Manchester.—The City Council on Wednesday confirmed the letting of a number of important contracts. Included in the contracts are those with the Electrical Company, Limited, for the supply of two 6,000-H.P. slow-speed engines, three-phase generators and motor-generators for Stuart Street station at £113,000; with Messrs. C. H. Normanton & Son for the whole of the builders' work required in connection with the engine and boiler houses at Stuart Street station; with Messrs. A. R. Bullivant & Sons for the erection of buildings, &c., required for the sub-stations at Heaton, Norris and Denton; and with Messrs. T. & W. Meadows for the erection of buildings, &c., required for the sub-station at Levenshulme.

Middlesboro'.—The E.L. contract for the North-Eastern Railway Company's new power station at the Middlesboro' Docks has been let to Messrs. Baker Bros., Middlesboro' and Stockton.

Perth (W.A.).—The contracts for extension plant for the Perth Gas Company have been allotted as follows:—750-H.P. engine, Messrs. Willans & Robinson, Limited; 500-KW. multipolar dynamo, Messrs. Dick, Kerr & Co., Limited; water-tube boiler, with chain grate stoker and superheater (from Glasgow Exhibition), Messrs. Babcock & Wilcox, Limited; condensing plant and iron smoke-stack, Messrs. Grant, Ritchie & Co.; feed water pumps, Messrs. Clarke, Chapman & Co., Limited; electric cables, the Telegraph Manufacturing Company, Limited; switch gear, Messrs. Nalder Bros. & Thompson, Limited; meters, Messrs. Ferranti, the Bastian Meter Company, and the General Electric Company (1900), Limited.

Plymouth.—Messrs. W. Scott, Limited, of Leeds, have the contract to supply 300 tons of rails and fishplates to the Corporation at £7 12s. 6d. per ton for rails, and £9 2s. 6d. per ton for fishplates.

Wimbledon.—The U.D.C. has accepted the tender of Mr. G. W. Clarke for wiring and fittings at the generating station.

FORTHCOMING EVENTS.

Friday, December 6th.—At 8 p.m. Institution of Junior Engineers. Meeting at the Westminster Palace Hotel. Paper on "Street Railway Construction for Electric Traction," by Mr. F. S. Pilling.

At 6.30 p.m. Northampton Institute City Polytechnic, St. John Street Road, E.C. Distribution of prizes by the Marquis of Northampton.

At 8 p.m. Institution of Civil Engineers. Students' meeting. Paper on "Gas Engine Construction," by Mr. R. W. A. Brewer.

Saturday, December 7th.—City of London College Science Society to visit the works of the Baker Street and Waterloo Railway.

At 11 a.m. Institution of Electrical Engineers (Students' section). Visit to the Fulham Electricity Supply Works.

Tuesday, December 10th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting in the rooms of the Institution of Engineers and Shipbuilders, 207, Bath Street, Glasgow. "Aluminium: Notes on its Production, Properties and Use," by W. Murray Morrison, member.

At 8 p.m. Institution of Civil Engineers. Ordinary meeting. Paper to be further discussed:—"Train Resistance," by John A. F. Aspinall, M.Inst.C.E.; and a paper, "Motive Power from Blast Furnace Gases," by Bryan Donkin, M.Inst.C.E.

Wednesday, December 11th.—At 7.30 p.m. Institution of Electrical Engineers (Birmingham Section). Meeting in the Municipal Technical School, Suffolk Street. Dr. W. E. Sumpner will read short papers on "The Power Factor of Alternate Current Circuits," and "On the Workshop Testing of Dynamos and Motors." Experiments will be shown illustrating—(1) Slip in three-phase motors. Heyland's device; (2) Lag and lead in alternate current motors; (3) Resonance. The Nernst lamp and other apparatus will also be shown.

At 8 p.m. Society of Arts. Paper on "Aluminium," by Prof. Ernest Wilson, M.Inst.E.E.

At 3 p.m. Institution of Civil Engineers. Students' visit to Messrs. Maple & Co.'s new electrically-driven cabinet factory in Highgate Road.

Thursday, December 12th.—At 8 p.m. Institution of Electrical Engineers. Conclusion of discussion on "The Physical Properties of Certain Aluminium Alloys and Some Notes on Aluminium Conductors," by Prof. E. Wilson, member; "Some Principles Underlying the Profitable Sale of Electricity," by Mr. Arthur Wright, associate member.

Friday, December 13th.—At 5 p.m. Physical Society of London. Meeting at the rooms of the Chemical Society, Burlington House. Paper "On Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the equivalent Radius of a Coil," by Prof. Thomas R. Lyle.

Tuesday, December 17th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester Section). Meeting at Owens College. Paper by Julius Frith, A.M.I.E.E., and E. H. Lamb, B.Sc., on "The Breaking of Shafts in Direct-Coupled Units caused by Oscillations set up at Critical Speeds."

Thursday, December 19th.—At 7.30 p.m. Institution of Electrical Engineers (Dublin Local Section). Meeting at the Royal College of Science, St. Stephen's Green, Dublin. An address will be given by the chairman, Prof. W. F. Barrett, F.R.S.

"ELECTRICAL REVIEW" ELECTRIC TRACTION ISSUE.

OUR issue which appears on December 13th, will be known as our "Electric Traction" Trade number. It will contain a mass of material relating to electric tramway and railway matters, and will be about double the size of the ordinary issue of the ELECTRICAL REVIEW. On this account it is necessary to proceed to press somewhat earlier in the week than is our usual custom, and we shall be glad if all of our friends will note the latest time for sending in matter as follows:—

Notes, correspondence, and all matter for editorial columns, by *Wednesday morning*, 11th inst.

Copy for new advertisements, and corrections for standing advertisements, by *Monday morning*, December 9th.

Official Notices and small pre-paid advertisements can be received up to first po. *Thursday morning*, 12th inst.

NOTES.

Yorkshire College Engineering Society, Leeds.—Mr. Wilson, of the Brush Electrical Engineering Company, Limited, Loughborough, a former student of the College, delivered a lecture before the above Society on Monday, November 25th, taking for his subject "The Development and Utilisation of Electric Power for Traction." Dealing first with direct current systems, he pointed out the methods of generation and transmission of power from the station to the cars, and especially noted the system of series-parallel control. He then described the alternating current systems, and their modes of working. The lecture was fully illustrated by slides of various plants in use, and at its close an animated discussion took place, the proceedings terminating with a hearty vote of thanks to Mr. Wilson.

Glasgow University Physical Society.—The constitution of this society for the present session, 1901—1902, is as follows:—Hon. President, Lord Kelvin, G.C.V.O., F.R.S., &c.; Prof. A. Gray, LL.D., F.R.S.; Vice-President, W. Stewart, M.A., D.Sc.; secretary and treasurer, J. G. Gray, Esq., the Physical Laboratory, Glasgow (telephone No. 2,002).

Society of Model Engineers.—The third annual conversazione of the Society of Model Engineers was held at the Memorial Hall, Farringdon Street, E.C., on Saturday evening last. The chief feature was the exhibition of engineering models and electrical apparatus.

Calcium Carbide as a Reducing Agent.—As the numerous experiments carried out by Moissan, Warren, Tarugi, Frölich, and others upon the reducing power of calcium carbide, and its value as a metallurgical reagent, have given somewhat contradictory results, a fresh research upon the subject has been instituted by F. von Kügelgen, who has reported recently in the *Zeitschrift für Elektrochemie*. When lead oxide is mixed with calcium carbide, both in fine powder, avoiding excess of the latter, and the crucible is heated in a wind furnace, carbon dioxide is the only gaseous product, and the final reaction is $5PbO + CaC_2 = 5Pb + CaO + 2CO_2$. The action begins at incipient redness, but is incomplete, analyses showing that at such a heat only the calcium of the carbide acts as a reducing agent, the carbon being separated thus: $PbO + CaC_2 = Pb + CaO + 2C$. This reaction develops a good deal of heat, which is usually sufficient to raise the temperature to a point at which the carbon can exert part of its reducing power; when, or by the assistance of some external heat, the other portion of the main reaction is determined: $4PbO + 2C = 4Pb + 2CO_2$. If an excess of carbide is employed, only the calcium serves as the reducing agent; and the greater the excess, the more does the whole reaction approach the second equation given above. The heat developed by the interaction of lead oxide with calcium carbide is not sufficient to cause the decomposition to spread throughout the mass when it is started at one point. In some quantitative experiments, when anhydrous calcium chloride was added as a flux in order that the metal should separate as a button, the yields varied from 80 to 97 per cent., and the calcium in the lead was only between 0·04 and 0·20 per cent. When lead chloride is treated similarly, the reaction $PbCl_2 + CaC_2 = CaCl_2 + Pb + 2C$, liberates so much heat, and is so violent that it may be started with a match, proceeding explosively through the mass. The carbon liberated prevents the metal from cohering nicely, so that the yield is smaller than in the previous case. The lead contains 0·04 per cent. of calcium. By using a mixture of lead oxide and chloride, the violence of the second reaction is lessened, and the carbon may be made to act as a reducing agent as well as the calcium. A mixture of 150 parts of lead chloride, 120 parts of lead oxide, and 37·24 parts of 88 per cent. carbide was fired with a fragment of lead chloride and carbide only, and gave a button of metallic lead weighing 91 per cent. of the theoretical yield. With copper oxide the final reaction is the same as that with lead oxide. It proceeds more violently, but requires a higher temperature to start it. Within certain limits, the violence increases with the excess of carbide. A mixture of 40 grammes of copper oxide with 12 grammes of calcium carbide fired by a little copper chloride and carbide gave a yield of metal exceeding 90 per cent. When a large excess of carbide is used, the copper contains notable quantities of calcium: equal parts of copper oxide and carbide yielded a copper with about 1·07 per cent. of calcium in it. The reaction between copper chloride and calcium carbide is also more vigorous than that with lead chloride. It may be started with a match, and proceeds with explosive violence. The yield ranges from 80 to 95 per cent. of the copper. Similarly with lead, a mixture of the oxide and chloride of copper with calcium carbide (143, 60, and 32·5 parts respectively) may be advantageously reduced, as liberation of carbon is avoided. The decomposition can be started with a match, and is complete in a few seconds. By mixing copper chloride with the oxides of other metals alloys can be won at a single operation. For instance, 5 parts of copper chloride, 5 of zinc oxide, and 3·3 of calcium carbide gave a brass containing 86·40 per cent. of copper, 13·48 per cent. of zinc, and 0·0041 per cent. of calcium. Copper-tin bronzes may be prepared in an identical fashion. From 5 parts of copper chloride, 5 of manganoso-manganic oxide, 5 of copper oxide, and 3 of calcium carbide the author obtained an alloy containing 91·02 per cent. of copper with 8·88 per cent. of manganese, which was malleable enough to be hammered to a thin foil in the cold. Silver chloride is reduced by calcium carbide very smoothly, the metal being recovered as a single button. The reaction may be started with a match. The silver in one experiment contained 0·01 per cent. of calcium. The process should be useful for working up silver residues. Zinc oxide is not well reduced, though its chloride is; but the metal does not melt to a button. Mixtures of zinc chloride with copper oxide with or without nickel oxide, yield alloys. Tin behaves like zinc, but a mixture of stannous chloride and copper oxide gives a bronze. Bismuth oxide and chloride can be reduced easily, separately or mixed together. Chromium oxide in the furnace, or chromium chloride by simple application of a light, yields metallic chromium as a powder, but it contains much carbon. Alloys of lead and chromium can be obtained in the same manner. The oxides of molybdenum, tungsten, and manganese can also be reduced by calcium carbide in the furnace, yielding metallic powders. Manganous chloride gives a powdered manganese rich in carbon. Arsenic, iron and nickel may be similarly isolated. The hydroxides and chlorides of sodium and potassium are not completely decomposed; but in presence of molten metallic lead, no alloy of lead and sodium can be prepared. Magnesium oxide is not reduced by calcium carbide; its chloride is only imperfectly decomposed. Aluminium oxide and chloride yield only a powdery metal; and attempts to win an aluminium bronze were unsatisfactory. Cerium chloride gives a grey powder, which is presumably metal containing much carbon.

Appointments Vacant.—An assistant is required in the electrical engineering department at Accrington at £104; a clerk, also a shorthand clerk and typist, at Hackney electricity works at £200 per annum and 35s. per week respectively; a shift engineer is required for Buxton; a junior assistant engineer is wanted for Hanley electricity works at £100 per annum; a switchboard attendant for South Shields; and an electrician-in-charge is wanted for Folkestone.

Water-Power in New Zealand.—Great strides in the development of water-power for electrical purposes are being made in New Zealand. The New York *Electrical Review*, referring to the matter, says that the latest project on foot is to utilise the water of the Wiamakariri River for generating electricity for the proposed electric tramways at Christchurch and for electric lighting. In accordance with instructions, Mr. Robert Hay, M.I.C.E., has prepared a report for the Christchurch Corporation on the subject, and of the two schemes submitted to him, he recommends that known as the George bridge project. The race to be constructed at the point of intake will be about six miles in length. A good site has been selected for the power station on the banks of the river, and the engineer considers that a permanent foundation for the building and machinery may be obtained without risk of encroachment by the river. The power required at Christchurch is 3,000 H.P., for which Mr. Hay estimates it is necessary to provide 5,000 H.P. at the generating station. The fall at the point of delivery having been fixed at 90 feet, the required flow of water will be 489 cubic feet of water per second, and allowing 7½ per cent. for sundry losses by bends, &c., the capacity of the race must be equal to a discharge of 525 government heads of water. Dealing with the subject generally, Mr. Hay draws attention to the danger of interference with the supply of power through interruptions of the water supply from various causes. He, however, considers the scheme quite feasible, and thinks the actual works for conveying 500 to 600 heads of water from the Wiamakariri to the site of the proposed power house can be successfully carried out, and utilised for the purpose of providing power for generating electricity for transmission to Christchurch. He estimates the cost of the work from the intake at the Wiamakariri to the pipe head at the termination of the race, including inlets, tunnels, race excavation, concrete lining, benching, new race and piping, at £54,700. Turbines with connections, generators, switchboards, transformers, exciters, meters, buildings, &c., would also have to be estimated for, but with these Mr. Hay does not deal. He recommends, in conclusion, that the corporation should lease or sell the concession to a private syndicate to carry out the scheme, reserving a right of purchase.

Steam Pipes and Boiler Mountings.—The Manchester Steam Users' Association calls attention to the use of so-called cast-steel for boiler mountings. It would appear that the term cast-steel is rather elastic, and has been made to cover materials which, while perhaps stronger than cast-iron, do not possess the elasticity one associates with steel proper. The Association thinking that "cast-steel" might "legally be considered to embrace these alloys," now stipulates "mild cast-steel," about which there can "be no misunderstanding." We are glad to see that this stand has been taken by the Manchester Steam Users' Association, for at least one instance has come under our notice where misunderstanding has arisen in respect of the material for boiler mounting blocks owing to a difference of opinion as to the material covered by the words "steel" or "cast-steel." Engineers generally will not, we feel sure, care to take risks with materials analysing like steel that have not been manufactured on approved lines known to produce safe material. Indeed, we would rather rely on a manhole mouthpiece welded up from a good rolled section than on a casting of doubtful elasticity—not that a good mild steel casting properly so called is not perfectly reliable. The Association, however, refers to material of as low a tensile strength as 6 tons per square inch. The trouble with steel castings of good quality has been that they are so full of blowholes, but there are one or two firms who do make a good casting. Otherwise it might almost be necessary to revert to cast-iron. We would ask how it is that steel castings are so very costly in this country. They are perhaps less than half the price in America, or even cheaper than that, and by no means always bad, though we have seen, it is true, shocking examples of bad steel castings from there. The Association has also a few remarks on steam pipes, with the perennial but necessary warning about water. In one case a plug of water struck the brass valve of a junction valve, turned the valve inside out, and drove it through its seat into the boiler against 150 lbs. steam pressure without even breaking the valve casing. It is pointed out that no case is known of an isolating valve having acted, but the fear is expressed that if one of these heavy balls were set in motion by the sudden flow of steam it would fracture its seat. Possibly a few figures would help us here. A ball of 8 in. diameter weighs about 70 lbs., and at 150 lbs. pressure has a push on it of about 7,500 lbs. It will thus be hurried against its seat with a force 107 times gravity. If it is closing a 6-in. hole it will rest at least 1½ in. from the seat, to which it will travel in less than ·01 of a second if our figures are right, and will thus inflict a very heavy blow on the seat. We believe these isolating valves are allowed very much more run than the proportion we indicate, and there certainly appears reason to doubt their safety. Such a valve requires a greater ratio of inertia to the propelling power behind it before it can be safe. Copper is not advised as a material for bends. Steel is far more elastic. Bends to allow for expansion are best placed horizontally, so as not to interfere with water drainage. The stretch of a bend or loop is proportional to its mean height, and inversely as the square of the diameter of the pipe. To take up stresses, therefore, bends ought to be thin, but to provide for expansion of a long pipe they should be as thick as the pipes. When coupling up a boiler to a range of pipes, the junction valve on the boiler should be placed on the top of a vertical branch as high as the main steam pipe, so that water cannot accumulate over the valve. From the junction valve the branches from each boiler should preferably enter the top of the steam main rather than its side; the steam main should fall towards one end for drainage purposes, and should be drained by a trap to the feed well. When

several boilers and engines are connected to one steam main this may be brought quite low at the back of the boilers, where circumstances favour the position, and the engine pipes also branch out from the top of the main, this system allowing great freedom for expansion. There is a danger that where the engine branch has a shut-off valve just over the main this may leak slightly, and water may collect above the valve and cause water hammer should the valves be opened. Any vertical pipes above valves should have drain pipes and separate traps. Every steam pipe arrangement is, in fact, very apt to be full of little pockets, and should be carefully examined for these before being decided upon, and such eliminated, or, if unavoidable, rendered safe by proper drainage. It is rather the habit to assume that the expansion of a steam main needs to be taken up entirely as between itself and the boilers. This is not, perhaps, quite true, for the brick seating of a boiler has an expansion probably not far inferior to that of the steam pipes. It must be remembered that the bricks are hot—about 1,000° —and the steam pipe is comparatively cool. At some point in a long steam pipe it is, perhaps, desirable to anchor it. Where liable to move by pressure, as in the case of expansion joints, the anchorage must be good and ample. As pointed out by the Association, steam pipes are boilers by Act of Parliament, and bring owners under the same responsibilities.

National Electrical Contractors' Association.—The members of the Northern Section of this Association met at the Hotel Metropole, Leeds, on November 23rd, Mr. Wallis (Leeds) presiding. Representatives were present from Leeds, Newcastle, Sunderland, West Hartlepool, Huddersfield, Bradford, Stockton, Middlesbrough, York and Ossett. Mr. Bland (West Hartlepool) moved the following resolution, which was seconded by Mr. Gowdy (Newcastle), well supported, and carried unanimously:—

That a sectional association comprising the North of England embraced by Berwick and Carlisle on the north, and Hull, Sheffield and Manchester on the south, be formed, with the object of easier organisation and combination for mutual interests of the respective local associations in their districts.

It was decided that the officers of the Association consist of a president, three vice-presidents, secretary and treasurer, and a delegate from each local section (an association with more than eight members to send two delegates). The following officers were elected—President, H. Bland (West Hartlepool); vice-presidents, E. J. Dugdill (Manchester), E. C. Wallis (Leeds), S. H. Gowdy (Newcastle); hon. sec. and treasurer, W. Cross. Rules were proposed as follows, as well as one or two minor rules:—

That the Association consist of the various local sections in the district, bounded on the north by Berwick and Carlisle, and on the south by Hull, Sheffield and Manchester.

That two general meetings and four executive meetings be held annually in towns selected by the executive.

That the objects of the Association be—(*a*). The better education of the non-technical public and the raising of the status of the skilled electrician; (*b*) mutual protection in trade disputes; (*c*) the protection of general trade interests.

It was decided to hold the next meeting in Manchester on the third Saturday in January. Secretaries of local associations in this district are requested to communicate as soon as possible with Mr. W. Cross, 4, St. Nicholas Buildings, Newcastle-on-Tyne.

Electrical Apparatus for Steering Ships.—It is stated that experiments have just been completed in Lord Crawford's steam yacht *Valhalla*, at Cowes, with the Hon. R. Brougham's invention for steering ships with electrical apparatus.

Electrically-Lighted Buoys.—A system of electric light buoys for the narrow channels of rivers is to be given a practical trial on the St. Lawrence between Montreal and Quebec. An electric cable is to be sunk in the middle of the navigable channel, and is to be connected to two lines of electric lights, supported by cork floats, one on either side of the channel. Power will be transmitted from Montreal, and it is proposed to have the lights on one side of the channel of a colour different from those on the other side.

Personal.—Mr. C. C. Howard, assistant traffic manager of the Liverpool tramways, has been appointed traffic manager of the Bolton tramways, with a salary of £250 per annum, advancing to £400. Mr. Howard has been connected with the Liverpool tramways for 21 years. He was selected by the Bolton Tramways Committee out of 50 applicants for the vacant position.

The *Daily Telegraph* announces the retirement of Mr. H. W. Brookman, superintendent at the Central Telegraph Office, St. Martin's-le-Grand, who ceases active work at the end of the year. He began his official career as an operator in the Magnetic Company just before the outbreak of the Crimean War, and was transferred to the Government service in 1870, when the undertaking was purchased by the State.

Mr. J. E. Turner, having resigned his position in the Electrical Sundries Company, is now representing Messrs. A. Emanuel & Son, Limited, manufacturing electricians, 9, 11, 13, George Street, Manchester Square, W.

It is announced that Mr. J. H. Stanhope, late of Leeds, and recently the sectional engineer of the Post Office Telegraphs at Bradford, has been appointed engineer-in-chief of the Central Telephone Exchange in the metropolis.

Mr. C. W. Shepherd, who has been traffic manager on the Harpurley section of the Manchester Corporation tramways for eight years past, has been appointed traffic superintendent of the Bradford Corporation tramways at a salary of £200. Mr. Parkinson, the tramway inspector of the Bradford Tramways and Omnibus Company, Limited, lost the position by one vote only.

Ball Lightning.—Tœpler suggests an explanation of the mysterious ball lightning, founded on some interesting experiments he has made on the discharge from a large multiple plate influence machine. When one of the electrodes of the machine is a metal point, and the other is a disc of some semi-conducting material, such as slate or basalt, an almost continuous discharge takes place, which appears at first as a glow, then, with increasing strength of current, becomes a tuft discharge, and a tuft arc light. If a metal ball, which may or may not be insulated, is held between the poles, the same phenomena show themselves on it as if it were an electrode, *i.e.*, tufts, &c., are formed on it. An aperture in a non-conductor, such as a plate of mica, behaves much the same as the metal ball, a mass of light being formed in the aperture when the plate is held between the electrodes of the machine. With sufficiently strong current a row of luminous masses separated by non-luminous spaces form in the path of the current on each side of the plate of mica, just as if the current alternately expanded and contracted in section. Tœpler considers that these luminous masses may be produced by atmospheric discharges, and give rise to the appearance of ball lightning. Tœpler's experiments are described in the *Annalen d. Phys.*, Vol. vi., p. 339.

Late Correspondence.—As we go to press the following letter comes to hand:—"In your current issue, I notice a letter from Mr. H. T. Harris, in which he takes exception to the Everett, Edgcumbe horse-power meters,, apparently on the ground that his own firm have, at some time or other, worked out the horse-power corresponding to various currents at a given voltage, and marked the scale accordingly. That they may have done so I do not for a moment doubt. It is not, in fact, by any means an operation attended with insurmountable difficulties.

"However that may be, I can confidently say that Messrs. Everett-Edgcumbe & Co. do not for a moment claim to have originated a new principle any more than M. Santos Dumont would, I should imagine, claim to be the first person who attempted to fly.—Kenelm Edgcumbe, London."

Water-tube Boilers.—The London correspondent of the *South Wales Daily News* says that the Japanese Government, which in future will build its own warships, has decided to stick to the water-tube system of boiler. It has tested the Belleville against the Niclausse boiler. The Italian and German Governments will probably also institute a series of comparative tests.

Country House Lighting.—The National Electric Wiring Company's Liverpool branch has obtained an order from Earl Derby, K.G., for the complete electric lighting of Holwood House, near Bromley, Kent.

Municipal Trading.—Last week, at the opening meeting of the session of the Statistical and Social Inquiry Society of Ireland, held in Dublin, his Honour Judge Shaw, the president, read a paper on "Municipal Trading."

For Sale.—The Colchester Corporation is offering certain electrical plant, lamps, and lighting accessories for sale. See "Official Notices" to-day.

THE CENTRAL STATION ENGINEER.

Mr. J. Spencer, switchboard attendant at Bolton electricity works, has been appointed junior assistant engineer to the Cheltenham Corporation Electricity Department.

Mr. Herbert Broadbent, manager of the Perth (W.A.) electricity works, who has been in this country for some months for the purpose of purchasing extension plant for his company, has left for Australia. The Perth Gas Company has over 1,000 electricity customers, and generates 1,000,000 units per annum.

Mr. W. M. Rogerson, chief assistant engineer in Nottingham Corporation Electricity Department, has been appointed electrical engineer for Halifax. The salary is £400 per annum. Mr. J. M. Smyth, of Keighley, and Mr. R. Blackmore, of Wakefield, were also interviewed.

At the last meeting of the Buxton U.D.C., it was resolved that the assistant electrical engineer (Mr. Leeming) be appointed electrical engineer to the Council at £150 a year, with the usual premium from one apprentice if required. Mr. Calvert was appointed consulting engineer until the completion of the new works, subject to the committee being satisfied as to terms.

The West Ham Borough Council, at their meeting on Tuesday, the 26th ult., agreed to the following increases in salary:—Mr. W. J. Bullock, mains superintendent, £175 to £225 per annum; Mr. S. H. Cushing, chief clerk, £150, by £10 per annum, to £200; Mr. A. France, shift engineer, £2 2s. to £2 10s. per week.

On Saturday evening last a complimentary dinner was given to Mr. A. J. L. Plunket, late power superintendent of the Kidderminster and District Electric Light and Traction Company, on his leaving to take up the position of chief engineer at Merthyr Tydvil. At the conclusion he was presented with a pipe rack and case of pipes from his colleagues on the managing staff.

NEW COMPANIES REGISTERED.

Electric Equipment and Securities, Limited (72,015).—This company was registered on November 29th, with a capital of £100,000 in £1 shares, to acquire and deal with real and personal property of all kinds, and in particular lands, railways, buildings, hereditaments, business concerns and undertakings, mortgages, charges, annuities, patents, licenses, shares, stocks, debentures, securities, book debts, claims, and the like, to act as an electric light company generally, and to carry on the business of electricians, electrical, mechanical, gas, and general engineers, suppliers of electricity for light, heat, motive power, and other purposes, manufacturers of, and dealers in, all apparatus and things required for, or capable of being used in connection with, the generation, distribution, supply and employment of electricity, fitters, founders, millwrights, wire drawers, tube makers, metal workers, coal and coke merchants, manufacturing, analytical, and general chemists, chemical manufacturers, lamp, stove, furnace and grate manufacturers and merchants, ironmongers, financiers, &c. The first subscribers (each with one share are:—H. Slaney, 4, Bishopsgate Street Within, E.C., accountant; A. W. Birch, 150, Cromwell Road, S.W., major; G. Marnti, 318, Dashwood House, New Broad Street, E.C., gentleman; A. H. Dibley, 12, Cornfield Terrace, Eastbourne, clerk; H. Richards, 318, Dashwood House, New Broad Street, E.C., gentleman; G. H. Deeks, 39, Ampthill Square, N.W., gentleman; and A. E. Barnard, 277, Lewisham High Road, S.E., gentleman. Minimum cash subscription, 10 per cent. of any shares first offered to the public. The number of directors is not to be less than three nor more than seven: the subscribers are to appoint the first; qualification, £100; remuneration, £100 each per annum.

Gjers, Mills & Co., Limited (72,017).—This company was registered on November 29th, with a capital of £270,000 in £100 shares, to acquire as a going concern the business now carried on at Middlesbrough-on-Tees under the style of "Gjers, Mills & Co," to adopt an agreement with John Mills and Lawrence F. Gjers, and to carry on the business of ironmasters, mine owners, iron and steel manufacturers, manufacturers of electricity for sale in bulk or by retail, and both for public and private purposes, colliery and wharf owners, wharfingers, lime burners, miners, workers of and dealers in iron, iron ore, ironstone, limestone, steel, coal, coke, slate, clay, bricks, gas, and all ores, metals, and mineral substances and their products, mechanical, electrical and general engineers, suppliers of motive power, shipowners, carriers by land and sea, &c. The first subscribers (each with one share) are:—L. F. Gjers, Busby Hall, Northallerton, ironmaster; J. Mills, Newham Hall R.S.O., Yorkshire, ironmaster; J. V. Cooper, Westbrook, Middlesbrough, secretary; C. E. Mills, Tanton Hall, Stokesley gentleman; A. H. Mills, Curraghbawn, Nenagh, Ireland, gentleman; W. H. Mills, West Moor, Marton R.S.O., Yorks., solicitor; and Mrs. A. G. Gjers, Busby Hall, Northallerton. No initial public issue. The number of directors is not to be less than three nor more than five. The first subscribers are J. Mills (chairman), L. F. Gjers, J. V. Cooper, and C. E. Mills. The two first named may each retain office so long as he holds £10,000 shares, with £8,500 paid or credited as paid thereon; qualification of ordinary directors, one share; remuneration of ordinary directors, £100 each per annum. Registered office, Ayresome Ironworks, Middlesbrough.

United Electric Light and Power Supply Company, Limited (72,024).—This company was registered on November 29th, with a capital of £15,000 in £1 shares, to acquire from Oliver Moon and John A. Loughlin for £3,000 a concession granting the exclusive right of supplying electricity to the town of Guimaraes, in the province of Minho, North Portugal, and to carry on in Great Britain, Ireland, Portugal, or elsewhere the business of suppliers of electricity for light, heat and power, electrical and mechanical engineers, makers of cables, wires, lines, accumulators, lamps, works and electrical apparatus, suppliers of fittings, motors, arc lamps, and other accessories, &c. The first subscribers are:—J. A. Loughlin, The Mount, Higher Broughton, electrical engineer, with 50 shares; A. R. Parker, Wellington Terrace, Ardwick, architect and surveyor, with 50 shares; W. Taylor, Rose Villa, Ardwick, Manchester, electrical engineer, with 50 shares; F. Taylor, 75, Spear Street, Manchester, brace manufacturer, with 30 shares; W. H. Taylor, Glannant, Carmarthen, electrical engineer, with 50 shares; O. Moon, Clifton Road, Chorlton-cum-Hardy, electrical engineer, with 50 shares; and A. H. Gregory, 78, Rawson Street, Farnmouth, yarn salesman with 30 shares. Minimum cash subscription, £2,000. The number of directors is not to be less than two nor than five; the first are John A. Loughlin, Wright Taylor and Alfred Parker; qualification, £50; remuneration, £15 per annum. Registered office, 9, Albert Square, Manchester.

Liquid (Electric) Register Syndicate, Limited (71,985).—This company was registered on November 26th, with a capital of £9,000 in £1 shares, to adopt an agreement with Gerald S. Hertslet and Edward S. Morris, and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of all apparatus and things connected with the generation and employment of electricity, &c. The first subscribers (each with one share) are:—J. A. Innes, 42, Stockfield Road, Streatham, S.W., stationer; R. M. Gauntlett, 253, Ivydale Road, Nunhead, S.E., stationer's manager; E. Swain, 6, Churchill Terrace, Huxley Road, Leyton, clerk; F. M. Hewland, 12, Earl Road, S.E., book-keeper; S. T. Richards, 20, Beulah Road, Thornton Heath, clerk; G. W. Mecham, 4, Leopold Road, Walthamstow, clerk; and G. Cooper, 24, Colchester Avenue, Manor Park, Essex, clerk. No initial public issue. The subscribers are to appoint the first directors; qualification, £200; remuneration, £100 per annum for the chairman, and £50 each for the others. Registered office, 110, Cannon Street, E.C.

Electrical Machinery Developments Company, Limited (71,004).—This company was registered on November 28th, with a capital of £10,000 in £1 shares, to carry on the business of financiers, promoters, contractors, constructors of railways, tramways and electric and other works, builders, &c. The first subscribers (each with one share) are:—F. W. Lowther, 151, Cannon Street, E.C., contractor; E. J. Haggar, 13, Ferron Road, Clapton, N.E., accountant; T. H. Jones, 14, Ainsworth Road, Croydon, clerk; C. S. Keeble, 27, Soames Street, Denmark Park, S.E., engineer's assistant; W. E. Hopper, 47, Glenelg Road, Acre Lane, Brixton, S.W., secretary; H. E. Brougham, 336, Romford Road, Forest Gate, shorthand writer; and R. M. Wellman, 22, Albert Road, Leyton, clerk. No initial public issue. F. W. Lowther is managing director for life.

Clayton Engineering and Electrical Company, Limited (72,014).—This company was registered on November 29th, with a capital of £60,000 in £1 shares, to acquire all or part of the undertaking, business, assets and liabilities of the Clayton Engineering and Electrical Construction Company, Limited, to adopt an agreement between M. Whiteley, the liquidator of the Clayton Engineering and Electrical Construction Company, Limited, of the first part, the Clayton Engineering and Electrical Construction Company, Limited, of the second part, and John Morris (as trustee for this company) of the third part, and to carry on the business of common carriers, carriers of passengers, live stock, produce, goods, minerals and merchandise, electrical, mechanical, hydraulic and general engineers, electricians, contractors, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, boiler makers, wire drawers, iron and brass founders, contractors for electrical installations, builders, electrical tramway, railway and light railway constructors, &c. The first subscribers (each with one share) are:—E. J. Byrne, Gravelly Hill House, near Birmingham, gentleman; J. B. Bedson, Newton House, Hyde, M.Inst.C.E.; G. Ward, 14, Brown Street, Manchester, C.A.; J. M. Binstead, Ashton-on-Mersey, C.A.; H. V. Bowen, Ivy House, Higher Openshaw, Manchester, electrical engineer; M. Whiteley, 17, Knight Street, Hyde, secretary; and C. H. Blyth, Green End, Burnage Lane, Didsbury, clerk. No initial public issue. The number of directors is not be less than two nor more than seven, provided that the Law Guarantee and Trust Society, Limited, may, so long as they guarantee any of the debentures of the company, appoint a special director, who shall not be required to hold any qualification; qualification of ordinary directors, £250; remuneration of ordinary directors, £200 each per annum; of chairman, £250; of special director as fixed by agreement.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

C. Lindley & Co., Limited (69,356). — Particulars of registered mortgages and charges. Date of creation of mortgage securing debentures, April 29th, 1901; total amount secured, £5,600; date of resolution creating series of debentures, May 1st, 1901; particulars of property mortgaged or charged. A specific charge on leasehold hereditaments (1) 34, Englefield Road, Hackney; (2) ground in rear of 105, Mortimer Road, Kingsland; and (3) part of 9, Waingate, Sheffield; and a floating charge on all the company's assets and property, including uncalled capital. Trustees, R. H. N. Lindley, W. C. Lindley and J. S. Crowther; date of present issue, April 29th, 1901; amount of present issue, £5,600 in 56 debentures of £100 each.

British Aluminium Company, Limited (41,104). — This company's annual return was filed on October 16th, when the entire capital of £400,000 in 10,000 "A" 6 per cent. preference, 20,000 7 per cent. preference, and 10,000 ordinary shares of £10 each had been taken up. £10 per share has been called up on all the "A" preference, 16,770 7 per cent. preference, and eight ordinary shares, resulting in the receipt of £262,270. £5,510 remains in arrears. £132,220 considered as paid on 3,230 7 per cent. preference and 9,992 ordinary shares. No mortgages or charges.

Mather & Platt, Limited (60,387).—This company's annual return was filed on October 15th, when 32,505 preference and 40,000 ordinary shares were taken up out of a nominal capital of £775,000 in 37,500 preference and 40,000 ordinary shares of £10 each. £10 has been called up on each of 21,705 preference and 2,500 ordinary shares, resulting in the receipt of £242,050. 10,800 preference and 37,500 ordinary shares considered as fully paid. No mortgages or charges.

Electric Tramways Trust, Limited (69,080).—This company's annual return was filed on October 18th, when seven shares were taken up out of a nominal capital of £20,000 in £1 shares. £7 has been paid. No mortgages or charges. The original capital was £100. Increase registered in September, 1901.

Ferrolite Electric Syndicate, Limited (61,376).—This company's annual return was filed on November 4th, when 1,121 "A" and 21,910 "B" shares were taken up out of a nominal capital of £30,000 in 8,000 "A" and 22,000 "B" shares of £1 each. £1 per share has been called up on 1,021 "A" and 12s. per share on 100 "A" shares, resulting in the receipt of £1,081, £21,910 considered as paid on "B" shares. No mortgages or charges.

SUPPLY STATION ACCOUNTS.

Leyton Urban District Council Electricity Accounts.

The view we took two years ago when dealing with the periodically recurring deficit that appears as the result of the working of the Leyton Council's undertaking is supported by the accounts last issued. Leyton has attempted too much, and the quick and large return which alone could have enabled the revenue to run up with the costs and charges incurred has not been forthcoming. The consumer may benefit for a time, but when over £7,000 stands as a suspense account against the undertaking, we should not be surprised to hear that serious misgivings are felt as to the wisdom of continuing a policy which has failed to win success. What has happened is easily seen from these figures:—

Year.	Units sold.	Capital. £	Total cost. d.	Gross expenditure. £	Revenue. £	Average return. d.	Financial results. £
1897	123,797	28,247	2·59	1,971	2,437	3·49	−737
1898	248,905	47,047	2·40	2,491	3,417	3·20	−928
1899	423,476	71,528	2·63	4,634	6,072	3·44	−1,465
1900	608,674	98,022	3·02	7,662	8,752	3·45	−3,292

The loss has run up from a total of £1,336 in 1897 to £7,022 at the end of last year, and as each year has shown an increasing deficit upon its own working, it is almost obvious that the consumers will soon have to pay a remunerative price, or the rates over the whole district will be called upon to put money into their pockets.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£71,528	**£98,022**	£26,494
Number of units sold	423,476	**608,674**	185,198
No. of lamps connected...	20,741	**29,182**	8,441
Maximum load in KW.	378	**469**	91
Gross revenue	£6,072	**£8,752**	£2,680
Gross expenditure...	£4,634	**£7,662**	£3,028
Gross profit	£1,438	**£1,090**	−£348
Average price per unit sold ...	3·36d.	**3·37d.**	+·01d.

There is practically no change in the revenue account. The costs show several large increases; coal is higher by over ⅓d. per unit, but this is almost wiped out by reductions in wages, oil, &c., and repairs, leaving the works cost at a figure only $\frac{1}{20}$d. greater than before. It is only fair to show that £797 of the establishment charges are due to law costs which are of a special character, and that rent and rates now take £327 instead of the nominal 20s. of 1899. These are matters the engineer cannot control, nor has he any direct influence upon the sums required to meet interest and repayments. As things stand, however, the total cost is over 3d. per unit.

REVENUE STATEMENT.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Sale of energy	£5,922	3·36d.	**£8,548**	3·37d.	+ ·01d.
Meter rents	117	·07d.	**170**	·07d.	·00d.
Profit on wiring, &c.	10	·00d.	**24**	·01d.	+ ·01d.
Rents received: Premiums, &c.	23	·01d.	**10**	·00d.	— ·01d.
Gross revenue ...	£6,072	3·44d.	**£8,752**	3·45d.	+ ·01d.

COST OF PRODUCTION.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Coal and other fuel and unloading same.	£1,244	·71d.	£2,680	**1·06d.**	+ ·35d.
Oil, waste, water, and engine room stores.	324	·18d.	265	**·10d.**	— ·08d.
Salaries and wages incurred in generation and distribution, and attending street lamps.	1,327	·75d.	1,550	**·61 /.**	— ·14d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and renewal public lamps.	695	·40d.	807	**·32d.**	— ·08d.
Works costs ...	£3,590	2·04d.	£5,302	**2·09d.**	+ ·05d.
Rent, rates and taxes ..	1	·00d.	327	**·13d.**	+ ·13d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	674	·38d.	837	**·33d.**	— ·05d.
General establishment charges, stationery and printing, law charges and insurance.	369	·21d.	1,196	**·47d.**	+ ·26d.
Other expenses	—	—	—	—	—
Total costs ...	£4,634	2·63d.	£7,662	**3·02d.**	+ ·39d.

The increase in the net loss is £1,827. Of this £1,479 represents the growth of the financial charges. The gross profit was less by £348 than in 1899, and as then a loss of £1,465, the deficit without any increase in capital expenditure would have exceeded the previous year unless the heavy law charges could have been escaped, or the rates, &c., kept as before.

PROFIT STATEMENT.

	1899.	1900.
Interest on loans and deposits	£1,397	£2,170
Sinking fund for repayments	1,506	2,212
Net profit carried forward	—1,465	—3,292
Gross profit	£1,438	£1,090

Lancaster Corporation Electricity Accounts.

THAT it is not essential for an electricity supply undertaking to possess a large output in order that a profit may be made, is proved by the results of the Lancaster Corporation works. The engineer during the period we deal with below was Mr. W. Alan Fraser, and great credit is due to him for more than maintaining the record of the previous year. The net profit has nearly been doubled, in spite of an increase in the coal bill and heavier repairs.

GENERAL STATEMENT.

	1899.	1900.	Inc.
Total capital expenditure ...	£32,795	**£35,380**	£2,585
Number of units sold	277,259	**324,684**	47,425
Number of lamps connected ...	21,639	**25,060**	3,421
Maximum load in kilowatts ...	334	**366**	32
Gross revenue	£4,504	**£5,890**	£1,386
Gross expenditure	£2,347	**£3,163**	£816
Gross profit	£2,157	**£2,727**	£570
Average price per unit sold ...	3·88d.	**4·15d.**	+ ·27d.

In 1898, 157,564 units were sold at 5d., and 19,330 at 4d. These prices were reduced for the ensuing year, when 194,622 units were sold at 4½d., and 31,039 at 3d. Last year the extra cost of generation was covered by the charges being raised; 172,338 units were sold at 5d., 59,000 at 4½d., 18,795 at 3½d., and 21,877 at 3d. As a result the sale of energy brought in over 4½d. per unit, an increase of just over ¼d. upon 1899. The relation of recent outputs is as follows:—

	Generated.	Public lighting.	Private supply.	
1898 ...	220,329	27,672	177,014	204,684
1899 ...	316,749	51,598	225,661	277,259
1900 ...	370,607	52,674	272,010	324,684

Plant installed, 420 KW. 31 arcs. 24,590 lamps.

REVENUE STATEMENT.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Sale of energy	£4,478	3·88d.	**£5,610**	4·15d.	+ ·27d.
Meter rents	—	—	**1**	·00d.	·00d.
Sales and repairs of lamps and other apparatus	—	—	**245**	·18d.	+ ·18d.
Proportion of apprentices' premiums, costs refunded, and bankers' interest.	26	·02d.	**34**	·02d.	·00d.
Gross revenue ...	£4,504	3·90d.	**£5,890**	4·35d.	+ ·45d.

During the past three years coal and repairs have been steadily tending upwards, while oil, waste, &c, and establishment charges, have just as surely been on the down grade. The other items are not much different, except the last, which is not an engineering cost at all. The profit from fittings, &c, amounted to £22.

COST OF PRODUCTION.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Coal	£853	·74d.	£1,240	**·92d.**	+ ·18d.
Oil, waste, water, and engine room stores.	139	·12d.	131	**·09d.**	— ·03d.
Salaries and wages incurred in generation and distribution.	506	·44d.	589	**·44d.**	·00d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and street lamps.	337	·29d.	508	**·38d.**	+ ·09d.
Works costs	£1,835	1·59d.	£2,477	**1·83d.**	+ ·24d.
Rent, rates and taxes ..	113	·10d.	150	**·11d.**	+ ·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c., and audit fees.	218	·19d.	216	**·16d.**	— ·03d.
General establishment charges, stationery and printing, law charges and insurance	152	·13d.	118	**·09d.**	— ·04d.
Other expenses: Cost of labour and fittings upon consumers' premises.	29	·02d.	202	**·15d.**	+ ·13d.
Total costs ...	£2,347	2·03d.	£3,163	**2·34d.**	+ ·31d.

Owing to the increase in price, and in output, the revenue has increased by £1,386, while costs are greater by £816 only, improving the gross profit by £570. As the interest, &c, charges only absorb £64 more than in 1899, there is an augmentation of the net profits by £506, bringing the £671 of 1899 up to £1,177. Of this latter sum the larger part or £750 is placed to the reserve fund, a well-considered step, and the local rates receive practically the same amount as before.

PROFIT STATEMENT.

	1899.	1900.
nterest on loans	£935	£990
Sinking fund for repayments	551	560
Net profit carried to reserve fund	250	750
,, ,, to credit of district rates	421	427
Gross profit	£2,157	£2,727

CITY NOTES.

The Westminster Electric Supply Corporation.

AN extraordinary general meeting of this corporation was held at the registered office, Eccleston Place, Belgravia, S.W., on Wednesday, December 4th, when the following resolution was passed:—"That the capital of the company be increased from £550,000 to £800,000 by the creation of 50,000 new shares of £5 each, such shares to be called preference shares, and to carry a cumulative preferential dividend at the rate of £5 per cent. per annum on the capital for the time being paid up thereon, with a preferential right over the ordinary shares of the company in the distribution of the assets in case of the winding up of the company, such shares to be issued in such series at such times and prices and in such manner and with such regulations as to times for payment of dividends and otherwise, as the directors may from time to time determine." Lord SUFFIELD, who presided, said that the new capital was required for the extension of the business, which was continually expanding.

Stock Exchange Notices.—The Committee has appointed a special settling day as under:—Wednesday, December 18th. Maxim (Sir Hiram) Electrical and Engineering Company, Limited—134,500 shares of £1 each, fully paid, Nos. 20,001 to 154,500. Application has been made to the Committee to appoint a

special settling day in and to grant a quotation to:—Perth Electric Tramways, Limited—£150,000 5 per cent. first mortgage debenture stock.

Western Telegraph Company.—The directors have declared an interim dividend, payable on December 20th, of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended September 30th, 1901.

Commercial Cable Company.—A quarterly dividend of 1¾ per cent. and a bonus of 1 per cent. on the capital stock has been declared payable on January 2nd.

TRAFFIC RECEIPTS.

Birkenhead Corporation Trams.—During the four weeks which ended with November 17th, 632,500 passengers were carried on six electric car routes. Receipts for the four weeks, £3,116.

Blackburn Corporation Tramways.—The receipts for the week ending Nov. 29th were £459; corresponding week last year, £390; increase, £69. Total to date, £24,182; corresponding period last year, £21,448, increase, £2,734. Miles of track open, 8½.

Blackpool and Fleetwood Tramways.—The receipts for the week ending November 30th were £171; corresponding week last year, £137; increase, £34. Total receipts to date, £20,356; corresponding period last year, £19,713; increase, £643.

Bristol Tramways and Carriage Company.—The receipts for the week ending November 29th were £3,681; corresponding period last year, £2,988; increase, £693.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending November 22nd:—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Croydon*	439	210	—	47	15,476	1,558	—
Devonport ..	357	—	—	22	8,750	—	—
Dudley—Stourbridge	588	116	—	47	30,980	15,805	—
Gateshead	595	—	—	28½	16,791	—	—
Greenock-Pt. Glasgow	343	—	—	7	1,719	—	—
Hartlepool	191	3	—	47	10,688	1,314	—
Kidderminster ..	90	8	—	47	5,758	684	—
Merthyr	181	—	—	33	8,356	—	—
Oldham—Ashton ..	424	—	38	47	23,446	3,166	—
Poole	183	—	—	33	9,541	—	—
Potteries	1,328	188	—	47	65,756	19,162	—
Southport†	106	—	24	47	7,723	—	2,767
South Staffordshire‡	684	—	30	47	36,420	2,400	—
Swansea	388	10	—	47	20 709	4,253	—
Taunton	49	—	—	13½	1,165	—	—
Tynemouth	166	—	—	35	9,907	—	—
Wolverhampton Dist.	73	28	—	47	3,086	710	—

* Partly horse † Reconstructing. ‡ Partly steam.

Central London Railway.—The receipts for the week ending Nov. 30th were £6,862; corresponding week last year, £5,766; increase, £1,096. Total receipts from July 1st (22 weeks), £134,295. Miles open, 6.

City and South London Railway.—The receipts for the week ending Dec. 1st were £3,262; corresponding week last year, £1,901; increase, £1,358. Total from July 1st to date, £45,936; corresponding period last year, £35,860; increase, £10,076. Miles open, 6¼; corresponding period last year, 4¾.

Dover Corporation Tramways.—The receipts for the week ending November 30th were £170 1s. 3½d.; corresponding week last year, £157 12s. 7½d.; increase, £12 8s. 8d. Total to date, £10,456 16s. 7d.; corresponding period last year, £9,920 8s. 5½d.; increase, £536 8s. 1½d. Miles of track open, 3; Car-miles run, 1901, 5,379; 1900, 4,968. Number of cars, 1901, 12; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending November 29th were as follows:—D.U.T. Co., electric cars, £3,218 7s. 7d.; D.S.D. Co., electric cars, £696 6s. 10d.; total, £3,914 14s. 5d.; corresponding period last year—D.U.T. Co., electric cars, £3,265 8s. 11d.; ditto, horse cars, £24 15s. 10d.; D.S.D. Co., electric cars, £651 3s. 8d.; total, £3,941 8s. 5d.; decrease, £26 4s. 0d.; aggregate to date, £103,618 19s. 5d.; aggregate to date last year, £102,447 17s. 2d.; increase, £1,171 2s. 3d. The mileage worked is 45 miles electrically, as against 43 miles electrically, and two miles by horses, for the corresponding period last year.

Glasgow Corporation Trams.—For the week ending November 30th, 1901, £10,794 10s. 1d., compared with £8,999 18s. 6d. for corresponding week last year.

Liverpool Corporation Trams.—During the week ended November 15th, 1,850,000 persons were carried by the electric cars. Receipts, £8,542; increase, £424 upon the corresponding week of last year.

Liverpool Overhead Railway.—The receipts for the week ending Dec. 1st were £1,436; corresponding week last year, £1,569; decrease, £133 Total from July 1st to date, £34,986; corresponding period last year, £36,643; decrease £1,657. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The demand for money gives no indication of slackening, and day-to-day advances command about 3¼ per cent., while even more has been paid this week. Another instalment on the new Consols became payable on December 5th, which did not make for ease in Lombard Street, and there are the regular end-of-the-year fears being trotted out again with regard to a money squeeze in three weeks' time. Notwithstanding these influences, investment markets in the Stock Exchange are not bad by any means. The marking of Consols *ex* dividend on Monday helped to rally gilt-edged securities as a whole, and the only part of the globe where financial stress may be anticipated is New York, the gold exports being exceptionally heavy of late. The markets in which electrical investors are chiefly interested are maintaining their positions with considerable firmness.

Encouraged by the improving traffic receipts, City and South London varieties are distinctly good. The Ordinary stock now stands at the highest price attained this year, and is a full 18 points above the lowest. In 1900 the two ends of the seesaw were represented by 70 and 52. The shares have also participated in the better feeling shown by the stock, but the market in these—contrary to the usual precedent—is narrower than that for the stock. The senior securities of the company are harder, the 1891 Preference being 131½ and the 1896 Preference are 125; both are 5 per cent. Perpetual stocks. The 4 per cent. Debenture stock stands at 115, having risen this week, and is only 2½ points lower than Central London 4 per cent. Debenture, now at 117½. London, Tilbury and Southend is drooping somewhat at the suggestion to electrify part of the system: the Consolidated stock is quoted 137 to 140, and the market thinks fresh money may be wanted. Both the underground descriptions are coming to the front again, Metropolitans being 71 and Districts 26½. The latter stock, we fancy, is worth attention at the present time. Great Northern and City "A" shares remain at 8½, and there is no quotable change to report in any of the other electrical railway stocks.

The National Telephone agreement with the Government has aroused such fierce hostility, that the market prudently lowered the price of the Ordinary shares to a fraction under £4, in case telephone holders should be frightened into selling. Moreover, the splitting scheme is regarded with great disfavour, it being urged that all the Ordinary shareholders will be landed with odd lots, which it will take a long time to get settled into round amounts. The new issue of 6 per cent. Preference shares is another discouraging feature, and no market has been made in these. We should not care to advise a purchase of the latest comers, which, in our opinion, will probably hang round about par in a marketless condition. They are directly responsible for the fall of 2s. 6d. in National Telephone Third Preference. The terms of purchase are not altogether liked in the market, and although the general impression continues that the company has driven a very hard bargain with the Government, the shares are, for the moment, out of favour in the Stock Exchange.

In the Electricity Supply section, Charing Cross and Strand are weaker on the news that the company is thinking of an appeal for new capital on behalf of its City baby. The latter wants more money in connection with its extensions, and there is some doubt at present as to the form which the new emission should take. Brompton and Kensingtons are again harder, and present every appearance of advancing to 10, double their par value. Westminsters are inquired for, but are unaltered in price. New Notting Hill shares at 2¼ premium, keep hard, and generally, this department is being assisted with a good deal of business.

Callender's new shares are quoted at 9 premium, and the last day for sending in applications has now passed. The issue represents a bonus of 30s. to proprietors of the old shares, but we have heard of several people who calmly threw their papers into the fire with "other rubbish," much to the subsequent worrying of the company's secretary. The old shares are £15 middle, *ex* the bonus represented by the rights. British Aluminium Preference are flat at 5, the fall in copper being in some mysterious way connected with this depression.

London United Tramways allotments came out a few days ago, and a dual set of prices has now been established in dealings for cash, and for the special settlement, the Preference quotations being $\frac{13}{16}$ premium and $\frac{15}{16}$ premium respectively, while the Debenture stock is about 2 premium. British Electric Tractions are a good market, and a little buying of the Debenture stock has hardened the quotation. Potteries Electric 4½ per cent. Debenture is receiving attention, the stock standing now at 107. The Ordinary shares are 11½, the Preference 10; but there is no business doing in either. Calcutta Trams mark a 10s. rise at 12½. British Westinghouse Preference are better at 5¼ *ex* the 3s. dividend, and a large number of shares change hands daily. As we have pointed out on several occasions, these Westinghouse Preferences are a good speculative investment.

Telegraph securities call for little notice this week. Eastern Ordinary is a point better, but the 3½ per cent. Preference has eased off the same extent. The Western group displays a climbing tendency, and African Direct Debentures are 1 per cent. to the good. Anglo-American varieties are practically unchanged, with the exception of a fall of ¼ in Anglo "A," but we welcome the narrower quotation for Direct United States shares. The unreliably wide prices issued under the auspices of the Stock Exchange Committee are wholly discreditable to that body, and even the smallest improvement is something for which to be thankful.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Nov. 27th.	Closing Quotations Dec. 4th.	Business done during week ended Dec. 4th. 1901. Highest.	Lowest
82,300	African Direct Telegraph, 4 % Debs	100	...	...	...	98 —101	99 —102	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700l	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	78 — 83	78 — 83	...	...
804,720	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	52 — 55	52 — 55	52¼	...
3,097,640	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	98 —100	98 —100	99	98½
3,097,640	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	9½— 10	9¼— 9¾	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	3⅝	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	180 —190	180 —190	...	...
1,741,029l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	100 —102	101 —103	102	101½
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	5½	...
6,000	Do. 10 % Pref.	10	10 %	...	...	13½— 14½	13½— 14½	14½	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
30,000l	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	100 —104 %	...	...
60,710l	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10⅝— 11¼	11⅛	10⅞
104,300l	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	101½	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	137 —141	138 —142	140	139
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	93 — 96	92 — 95	95½	93
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	112 —115	112 —115	112	...
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13¾— 14¼	13¾— 14¼	14¼	14 1/16
320,000l	Do. 4 % Deb. Stock	Stock	...	...	...	113 —118	113 —118	115½	115
300,000l	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼%	...	100 —103	100 —103	...	...
200,000l	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103	100 —103	100⅛	100
180,227	Globe Telegraph and Trust	10	5¼%	5¼%	5¼%	11¼— 11¾	11¼— 11¾	11⅛	11⅛
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15¼	14⅜— 15¼	14⅞	...
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	30 — 32	...	...
78,000l	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	40 — 44	40 — 44	...	...
100,000l	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	102 —105	102 —105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ¾ xd	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1 xd	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	—	3⅜— 4	4⅜	3⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	4⅝— 5	5	4⅞
2,000,000l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	...	...
500,000l	Do. 4 % Deb. Stock Red.	100	...	...	4 %	99 — 102	99 —102	101⅛	100½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	1 1/16— 1 1/16	1 1/16— 1 1/16	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	127	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5⅛	5 — 5⅛	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
179,947l	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
155,600	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000l	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	14¼— 14¾	14¼— 14¾	14 9/16	14¼
75,000l	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	104 —107	...	...
348,777l	Do. do. 4 % Deb. Stock Red.	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	2 %	5%	...	⅜— ⅝	⅜— ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5½— 6½	5 — 6 xd	5 3/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3 — 5	3½— 4½	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104	101 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜ — ⅝	⅜— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	97 —102	97 — 102	...	...
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	8 — 8½	8½— 8⅝	8½	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¼— 8⅝	8¼— 8⅝	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	8¼— 9½	...	...
50,000	Do., do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 5⅜	5⅜	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	...	105 —107	105 —107	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5¼%	5¼— 5⅜	5¼— 5⅜	...	...
150,000l	Do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	0 %	9 — 10	9 — 10	9⅜	9¼
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	11½— 12½	11½— 12½	12⅛	1 7/8
400,000l	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	102 —105	102 —105	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8¾— 9½	8¾— 9½	8¾	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
400,000l	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	105 —108	105 —108	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5½— 6	5½— 6	...	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6	...	...
120,000l	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	105 —108	105 —108	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1¼— 1⅝	1¼— 1⅝	1¼	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	3½— 4½	3½— 4½	4	3 5/8
250,000l	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 —100	96 —100	...	...
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13½— 14½	13½— 14½	14⅜	13⅞
220,000l	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	113 —116	113 —116	...	...
250,000l	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	...	...
8,652	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16	15 — 16	15¼	15⅛
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½— 16½	15½— 16½	16	15 13/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	...	...
150,000l	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	97 —100	97 —100	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2⅛	2 — 2⅛	2⅛	...
50,000l	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 2⅛	2 — 2⅛	...	...
109,518	Westminster Electric Supply, Ord.	5	12 %	13 %	10½%	11½— 12½	11½— 12½	12¼	12

* Subject to Founders Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Nov. 27th.	Closing Quotation Dec. 4th.	Business done week ended Dec. 4th, 1901. Highest	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	5 — 6	4½ — 5½	5	4⅞
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	87 — 91	87 — 91	...	...
62,074	British Electric Traction	10	6 %	8 %	9 %	14 — 14½	14 — 14½	14⅜	14¼
93,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11⅜ — 12½	11⅜ — 12½	12 3/16	12 1/16
600,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	121 —124	122 —125	123	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	8 — 9	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½ — 5⅝	5½ — 5⅝	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	⅞ — 1	⅞ — 1	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	...	6 %	1 1/16 — 1 1/16 xd	1 1/16 — 1 1/16	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 105,731	2	4 %	5½ %	5 %	1⅜ — 1⅝	1⅜ — 1⅝	...	...
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	1⅞ — 2⅛	1⅞ — 2⅛	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
125,000*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102	99 —102	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	16 — 17	14½ — 15½	14⅞	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	5 13/16	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	112 —116	112 —116	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	107 —110	107 —110	109½	108½
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 —108	105 —108	106⅜	...
440,100	Do. do. Def. do.	Stock	...	...	...	107 —110	107 —110	...	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	60 — 63	63 — 65	65	63
47,500	Do. do. Ord. shares Nos. 22,501 to 70,000 ...	10	...	...	...	5½ — 6	6 — 6½	6½	5½
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	8 %	3 — 3½	3 — 3½	3⅜	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½%	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½%	1½ — 2½	1½ — 2½	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85	80 — 85	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	84 — 89	84 — 89	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1¾ — 2¼	1¾ — 2¼	1 1/16	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	7 %	...	...	2½ — 3	2½ — 3	2⅞	2¾
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102	98 —102	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	10 — 10½	10 — 10½	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 —102	99 — 102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16 — 17	16 — 17	...	...
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½ — 6	5½ — 6	5½	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	112 —116	112 —116	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	23 — 24	23 — 24	23 5/16	...
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3¾%	3½%	5⅞ — 6⅛	5⅞ — 6⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	12 — 12½	12 — 12½	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500 ...	10	...	...	...	15½ — 16½	15½—16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	... — ...	19/- to 20/-	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	38 — 42	38 — 42	39¼	...
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	104 —106	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½xd	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	91 — 94	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 2/—4/-
National Electric Free Wiring, 17/6 paid, ½—¾.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16.
Do. do. Pref. (£10 pd.), 10½—10¾.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (October 31st, 1901).

MARKET QUOTATIONS, Wednesday, December 4th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	32/-	32/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£22	£22	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8d.	8d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	135/-	135/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£8	£8	..
a Bichromate, casks ..	per lb.	2½d.	2½d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£294	£294	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	..
c Brass (rolled metal 9" to 12") basis	per lb.	7¾d.	7¾d.	..
c Tube (brazed)	per lb.	9¼d.	9¼d.	..
c „ „ (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c „ Wire, basis	per lb.	7¼d.	7¼d.	..
c Copper Tubes (brazed) ..	per lb.	10d.	10d.	..
c „ „ (solid drawn) ..	per lb.	10¼d.	10¼d.	..
g Copper Bars (best selected) ..	per ton	nominal	£80	..

METALS, &c. (*continued.*)		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	nominal	£80	..
g „ Rod	per ton	nominal	£80	..
c „ (Electrolytic) Bars ..	per ton	£82	£82	..
c „ „ Sheets ..	per ton	£90	£90	..
c „ „ Rod ..	per ton	£84	£84	..
c „ „ H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/5 to 3/7	3/5½ to 3/7½	½d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	42/9	43/5	8d. dec.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	47/6 to 50/-	50/- to 52/6	2/6 dec.
i „ Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£11 5	£11 7 6 to £11 10	dec.
g „ „ Sheet	per ton	£13 10	£13 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 17 6	£8 17 6	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/8	1/0½ to 1/8	..
p „ rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ „ strip & sheet	per lb.	From 1/8	From 1/8	..
c Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40	From £15 to £40	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	£113 to £114	£120 to £121	£7 dec.
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/7	1/7	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
f Yarns, 2/10s Grey Cotton, cn sp'ls	per lb.	7d.	7d.	..
f „ 6 lea. Flax	per lb.	5½d.	5½d.	..
f „ 3 ply 10 lbs. Russian ..	per lb.	4 1/16d.	4 1/16d.	..
f „ 15 lbs. Russian, single ..	per lb.	4¼d.	4¼d.	..
f „ 180 lbs. Jute rove	per ton	£15 2 6	£15 2 6	..
e Rags, Sh'ts. (Vielle Montagne bad.)	per ton	£22 10	£22 10	..

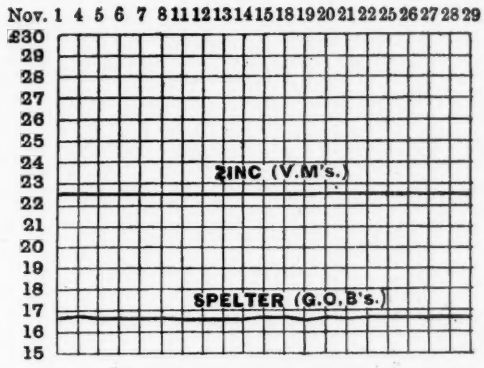
Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Jackson & Till. i Messrs. Bolling & Lowe. j Messrs. Walter M. Hindley & Co.

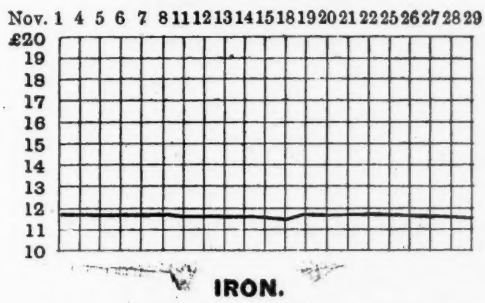
Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company, Ltd.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

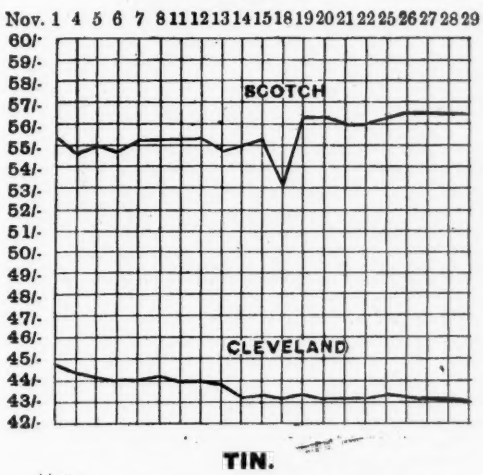
METAL MARKET.—Fluctuations in November.



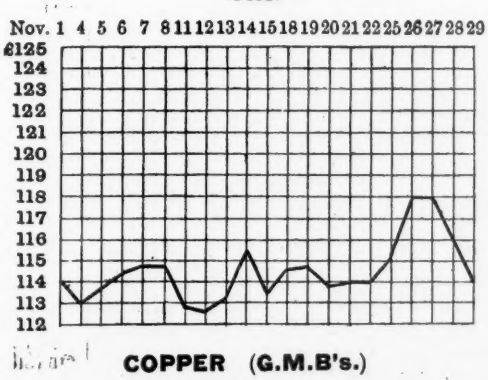
LEAD (ENGLISH).



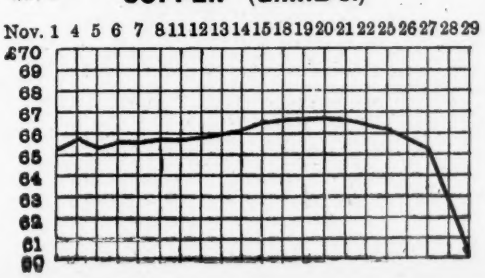
IRON.



TIN.



COPPER (G.M.B's.)



INSTITUTION OF ELECTRICAL ENGINEERS.

Abstract of Inaugural Address by Mr. W. Langdon, President.

(*Delivered Thursday, November 21st.*)

(*Concluded from page* 908.)

Distribution of Power.

In the development of schemes for the distribution of electrical energy, not merely for power, but for all purposes useful to the community at large, we, as a nation, are by no means singular. Other countries are equally availing themselves of them for various industrial purposes. Great Britain cannot boast of some of those great natural advantages enjoyed by other countries, but, although water-power is not ours to command, we have in our coalfields a product which there is every reason to believe will prove of equal value.

The time has come when we have to put to ourselves the question: To what extent are these schemes destined to aid economical manufacture, and the conveniences and needs of everyday life? To some extent this is an unsolved problem, but that they will prove a great and powerful factor in all industrial operations there can be no doubt.

Competition in the production of all marketable articles will, in the near future, be extremely keen. Equally sure it is that the advantage will lie with those who are able to produce at the least cost. It is only when we fully realise this that we see how important it is, in the welfare of the country, that every means by which production may be cheapened should receive our most careful and considerate attention. We feel that we are entering upon a contest with others—others possessing, to all intents and purposes, equal, if not more favourable, means than ourselves for the production of those very articles which we propose to produce. We see that in the establishment of the means for furnishing to those who need it the power which is to aid in this economical commercial propaganda, other lands are in advance of us; that we are only now awakening to the means by which it is given us to compete in this race.

The extent to which it may be carried must naturally resolve itself into a question of how far it will pay to do so. If it is confined to those localities where population is already congested, it will but tend to aggravate that condition of life, the relief of which it is felt is becoming one of the most serious questions of the day. A cheaper mode of construction would admit of greater latitude, and to this end it might be of advantage to consider whether, in practically unfrequented parts, the regulations which now attend the use of overhead wires, would admit of such modification as would confer upon these schemes a status which would tend to place them more upon a level with those of other countries.

If the establishment of these power schemes is to be of that service to our industries which may fairly be anticipated, it is of the greatest importance they should receive at our and other hands all the aid in our power. It is in searching out means for effecting economies and in securing the higher attainments of life that science plays its most useful part, and we must not forget its ultimate object. Science is but a means to an end. The scientist lays bare the principle. Others take up his parable and apply it to the use of mankind. It is in its application that we recognise the merit of the discovery and pay homage to its author. Its end has been for the benefit of the beings of the world.

Conclusion.

I feel that I cannot close these remarks without tendering to the members my hearty congratulations on the progress of the Institution. Although the funds at our disposal are not, in the interest of the objects of the Institution, so great as we could well desire, and though we have made but little tangible progress in the establishment of a permanent home, and still, with gratitude, record our indebtedness to the Institution of Civil Engineers for that great and generous consideration so gracefully accorded us in the use of this noble theatre, the Institution is doing work of which we have reason to be proud. The membership is a growing quantity, and with its growth the field of operations is widening. Local sections are adding their quota to the work done in the promotion and discussion of subjects material to the knowledge and development of electrical science; still the advantages of electrical agency and the simplicity of its application are largely unknown. Compare the simplicity of an electric motor with the details of a local steam or gas plant, and conceive when electricity is brought to our doors and its advantages are more clearly understood, how much of that machinery from which motion is now produced will be displaced by the electric motor. It is for you, gentlemen, in your communications and papers to be read and discussed before this and kindred institutions to remove this deficiency, to show by what is being daily accomplished the economies which lie in the use of electricity and the advantages it possesses over other forms of distributed energy.

Nor can I abstain from tendering to you my congratulations on the work of utility which awaits your efforts. No profession has before it so large a field as that which constitutes the basis of this Institution. I would that I could congratulate you on the extent of work done. Electrical development in England has not been so satisfactory as it should have been. Over-legislation—that great desire to protect the subject, often at the cost of that to which he has to look for his means of support, has, no doubt, retarded elec-

SCHEDULE A.—DETAILS OF ELECTRIC LIGHTING AND POWER INSTALLATIONS ON THE FOLLOWING RAILWAYS :—

Railway.	No. of arc lamps in use.	No. of incandescent lamps (16 C.P.) in use.	Approximate H.P. applied to power purposes.	Particulars as to purposes to which electrical energy is applied, and of important works in contemplation.	No. of coaches lighted by electricity, and system employed.
Lancashire and Yorkshire	500	6,800	1,460	*Oldham Road Goods Station (Manchester)*, wholly worked by electricity, viz., 22 18-H.P. capstans, two 40-H.P. motors operating wagon hoists; motors driving traversing cranes, gantries, and a number of 15-cwt. jiggers. Provender mills adjoining also operated electrically. The whole of these premises and yards also electrically lighted. *Bradford Warehouse.*—Three high-speed travelling cranes for unloading and storing wood, each operated by three motors. *Bolton.*—A power station has been built for operating whole of station—capstans and cranes (including 40-ton Goliath crane with longitudinal travel of 200 yds.) in goods yard; hoists in warehouses and on station platforms; air valves in connection with pneumatic signalling, and complete lighting of passenger station, offices, goods yard and signals. *At various stations.*—A number of small motors—of 3 to 5 H.P.—operating luggage hoists between subways and platforms, including an overhead Telpher track for parcels at Manchester, Victoria Station. *Liverpool Hotel.*—Passenger, dinner and coal lifts. *Newton Heath Locomotive and Carriage and Wagon Works.*—Portion of lathes, shafting, cranes and fans. *Steamers, Tug-boats and Dredgers.*—Lighted (including mast, side and signalling lights), and fans operated electrically. (The lighting of the *Fleetwood Docks*, including a large grain elevator, is accomplished by means of electricity.)	Six coaches and three saloons (Stone)
Midland	1,885	13,731	750 installed. 250 estimated for new work.	50 H.P. working pumps at 700 lbs. pressure for hydraulic lifts; 25 H.P. working compressor for pneumatic drilling, &c.; 78 H.P. working pumps; 83 H.P. working overhead traversers; 20 H.P. working wagon traversers; 135 H.P. working capstans; 35 H.P. working cranes, lathes, &c.; 15 H.P. working fans; 250 H.P. working granary machinery—chaff-cutters, elevators, crushers, hoists, &c.; 9 H.P. working miscellaneous.	11 (Stone)
North-Eastern ...	429	7,306	2,204	Travelling jib cranes, overhead travelling cranes, capstans, luggage hoists, goods warehouse travellers, ticket-printing and ticket-destroying machines, punching and shearing machines, saws, grindstones, paint mills, lathes, coke crushers, and ventilating fans. *In contemplation:* Important installations at Leeds, Hull, and West Hartlepool. Electric overhead travellers, cranes, hoists, and capstans for goods warehouse, Newcastle, and a number of arc and incandescent lamps being installed at the latter place, and not included in summary.	2 (system no stated)
South-Eastern and Chatham	308	2,392	122	*Slade's Green Locomotive Shed.*—Motors employed for pumping, for coaling engines, and for lathes, &c., in workshops. *In contemplation:* Installation for *Queenborough Pier* for lighting and for cranes and capstans.	925 (Stone)
London & South-Western	76	220	Nil.	*Southampton Dock.*—Large electrical installation. *Steamships.*—All "fitted" with electric light. *Fitting up Salisbury Station* (about 800 incandescent and 30 500-watt arc lamps).	326 (Stone)
North Staffordshire...	47	1,403	20	Used for driving machinery: lathes, cranes, luggage lifts, air-pump, ventilating fans, and for cooking, &c.	79 (modified Stone)
North British ...	369	2,681	10	One 10-H.P. motor for passenger elevator.	7 (Stone) 291 (Carswell)
Caledonian	480	6,014	90	Using for drainage pumping and hydraulic pressure pumping for operating signals; also in horse-provender stores (where provender is mixed for 1,070 horses). *New Works in Progress: Glasgow Central Station.*—Power station of 1,050-KW. capacity for lighting and power—for hoists, pumps, fans, traversers, &c. *Edinburgh.*—500 KW. additional plant, for hotel lighting and other purposes, with 2,000 16-C.P. lamps. *Stirling Station.*—500 incandescent lamps (station and offices). *Perth Station Hotel.*—450 incandescent lamps. *In contemplation: Glasgow, Buchanan Street Passenger and Goods Station, Head Offices, &c.*—Power station of 2,000-KW. capacity.	27 (Stone) 3 (Vickers and Maxim)
Great Eastern ...	8	405	Nil.	No motor load.	9 (Stone) 1 (by cells)
Great Western ...	166	8,764	Nil.		
Midland Gt. Western (Ireland)	—	—	—	Nil.	100 vehicles (Stone)
Great Northern ...	927	9,842	1,198	*Doncaster Works (Locomotive and Carriage and Wagon).*—Used for working 160 travelling cranes (35 tons and 20 tons load each), two walking cranes, one engine traverser, and for driving shafting in sections and some machine tools with separate motors.	88 (Radcliffe)
Cheshire Lines ...	219	763	Nil.	Used only for lighting.	8 (Stone)
Glasgow & S.-Western	185	5,050	40	Applied to overhead cranes and shop traverser.	6 (Stone)
Gt. Northern (Ireland)	84	529	750	Employed for working a tramway round the Hill of Howth—five miles. Generating house is at Sutton, and there are three engines, each of 250 H.P.	231 (Stone)
London, Brighton, and South Coast.	301	800	Nil.	But question of employment for power purposes is *under consideration.*	271 (Stroudley and Houghton) 215 (Stone)
Great Central ...	716	6,168	333	For air-pumps, water-pumps, electric lifts, travelling cranes, wood working machinery and iron turning. Lighting comprises whole lighting of following:—*Goods Depôts.*—Marylebone, Leicester, and Nottingham. *Sorting Sidings.*—Neasden, Woodford, and Annesley. *Warehouses.*—Marylebone, Leicester, Nottingham, and Liverpool. *Passenger Stations.*—Marylebone, Woodford, Leicester, Nottingham (Victoria), Sheffield (Victoria), Oldham (Clegg Street), and Manchester (London Road). *Receiving Offices and Depôts.*—London, Bradford, Liverpool and Manchester.	11 (Stone) 1 (Vickers and Maxim)
Great Southern and Western (Ireland)	57	15	Nil.		21 (Stone)
London & N.-Western	425	12,600	3,300	The working of points and signals, warehouse cranes, capstans, hoists, pumps, and shop tools.	830 (Stone)
Totals	7,182	85,683	10,527		3,452

SCHEDULE B.—MILEAGE AND OTHER DETAILS OF TELEGRAPHS AND BLOCK SIGNALLING ON UNDERMENTIONED RAILWAYS.

Railway.	Mileage of line on which the electric block is interlocked with mechanical signals.	Number of block posts where mechanical signals are operated by electricity.	Number of telephones for all purposes.	Number of telegraph instruments of all kinds, including block.	Mileage of wire employed for railway purposes.	Mileage of wire maintained for the Post Office Telegraph Department.
Caledonian	25	Nil	1,629	16,688	6,890	5,120
Cheshire lines	1¼	Nil	260	1,586	1,184	725
Glasgow and South-Western	4	13*	359	1,620	1,814½	1,888
Great Central	16¼	Nil	918	7,036	4,259	1,209
Great Eastern	59	109	715	11,704	6,777	4,802
Great Northern	3¾	16	6*4	10,427	7,747	4,379
Great Western	16	Nil	2,155	25,924	15,256	14,003
Lancashire and Yorkshire	Nil	Nil	1,950	8,380	5,229	2,268
London, Brighton and South Coast ...	80	Nil	600	2,944	3,500	2,434
London and North-Western	Nil	Several signals and points are worked experimentally at Crewe (by Signal Department).	2,361	10,450	13,500	8,200
London and South-Western	345	(Experiment) six automatic posts	1,213	14,663	7,325	7,947
Midland...	25	Nil	2,820	20,344	12,845	15,243
North British	5½	Nil	562	3,466	7,193½	3,622
North-Eastern	1	Nil	1,820	14,726	10,767¾	3,449
North Staffordshire	Nil	Nil	418	1,181	850¾	433½
South-Eastern and Chatham	350 (Double line)	Nil. 55 electrical shunting signals in use.	853	6,504	4,613	4,804½
Great Northern of Ireland	Nil	Nil	161	242	1,338	3,280
Gt. Southern and Western of Ireland	—	Not to hand.	—	—	—	—
Midland Great Western of Ireland ...	—	—	32	401	1,167	2,210
Totals	913¾	138	19,510	158,286	112,256	86,017

* G. and S.W. Railway. 66 electric signals operated by means of motor connected with each arm, worked from 30-volt accumulators. 57 disc shunt signals operated electrically by means of electro-magnet, worked from 8—12-volt accumulators. These numbers will be considerably increased when installation completed.

trical progress, and consequently the production of electrical machinery. Oft do we hear the cry for education. Educate! Educate! Certainly, let us educate, but of what avail is education without experience? Are our engineers deficient in education? Do those electrical plants and installations which have been established indicate a want of knowledge? Do they fail to favourably compare with those of a similar character in other countries? Why is it that America has forged ahead in electrical applications in the manner she has? Is it due more to education than experience? It is experience that has gained for her engineers and manufacturers the position they have attained in the provision of electrical equipment. It is this experience that has enabled them to determine that which is adapted to meet the demands arising out of this new power; to standardise it, and lay down plant for its manufacture.

Experience can only be obtained by actual work, and that actual work has been, by those to whom power to put it into operation has been assigned, delayed till the last moment when, perforce, much of it has had to be entrusted to those who were prepared to provide promptly the necessary parts. Work has been delayed, experience sacrificed, and much that should have enriched British industry has passed into other channels. I am sure that I do not stand alone in echoing the expression of the President of the Glasgow International Engineering Congress, Mr. Mansergh, the late President of the Institution of Civil Engineers, that what is needed is greater liberty—greater freedom—less restraint! Is electrical science in those applications to which I have referred destined to be of service to the public weal? Is it now serving the community with advantage? If so, is it desirable that statute limitations should interfere to preclude or to prejudice its progress? If found to be undesirable, or in any way injurious, nothing could be easier than to restrain its use. To do so in anticipation is to stay its progress and deprive the country of its value. Do not let us lose sight of the fact that when railways were being established throughout the country there were towns—certain towns—that declined to be associated with them, but in a very short time they became sensible of their folly and had to seek the suffrage of the railway—only, in some instances when too late, for they have been left out of the main route, and have never recovered their prestige. In these distribution of power schemes the country has before it something of value to its commerce equally great. Assume that a district desires to be exempt in order that it may provide for itself. Unless it can produce as economically as the larger scheme it must increase the local cost of production and injure its users, or drive them into another area where they may be more advantageously served.

It is in the full belief that electricity is destined to prove of the greatest service to the commonwealth and that its advantages have been too long retarded, that I have ventured to submit to your consideration these remarks. In doing so my effort has been to view the subject from that broad standpoint—the national interest; the benefit of the greatest number. This Institution is a composite body, embracing within its folds every branch of electrical science, having various interests to protect; but of this I feel sure, that however varied those interests may be, one and all its members are animated by but one desire—the progress and welfare of the country. We believe that electricity is to play a very important part in engineering work, and we are ambitious that England shall not sacrifice that high position in engineering science which has for so long distinguished her.

In what way, by what means, whether by private enterprise or by municipal effort, electrical progress is effected is not so material as that it is effected. So long as its fullest advantages are placed at the disposal of those who desire to avail themselves of them, you, gentlemen, as well as I, will welcome the means, whatever they may be.

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

Inaugural Address of the Chairman, Mr. C. H. WORDINGHAM.

(*Concluded from page 875.*)

ADMITTING for a moment the principle of municipal trading, what is its proper sphere, and what are its limitations? For very few, except professed communists, would advocate its indefinite extension. The city of Glasgow may be looked upon as the apostle of municipalisation, and therefore, in order to find the case fairly stated from the municipal point of view, I cannot do better than quote the Lord Provost of that city. In defining what, in his opinion, were the conditions necessary to render an industry a proper one for a municipality to take up, he stated that it must be monopolistic in its nature, must be a necessity for the inhabitants of the district, and must cause interference with the streets.

Such a definition, while allowing a large field for municipal enterprise, imposes well defined limitations. For example, it effectually cuts at the vicious principle of municipalities becoming manufacturers; by no possibility can any kind of manufacture fulfil all three conditions of being a monopoly, a necessity, and of causing interference with the streets. If municipalities stop short at the point indicated, and confine themselves to employing plant manufactured by private companies, and using it for the supply only of public necessities, the manufacturing portion of the electrical engineering profession, at all events, has nothing to lose and everything to gain by the establishment of undertakings for which capital is found at a low rate of interest.

The danger, however, cannot fail to be ever present that the bounds will be overstepped. For example, a large tramway undertaking must of necessity have extensive repair shops for both its cars and its motors. How great will be the temptation to keep these shops busy by making new cars and new motors? It is sound policy from a purely trading point of view, and those responsible for the financial success of the undertaking would be more than human if they let ideal considerations of the ethics of municipal trading stand in their way.

It is this danger of overstepping the bounds that leads many to disapprove of all municipal trading on the principle actuating the ardent temperance reformer when he will have nought of the moderate drinker, but less prejudiced persons hold that, if a thing is good in itself, it is a pity to condemn it for fear of abuse.

However satisfactory properly regulated municipal trading may be to the manufacturer, there are other issues affecting the industry generally that cannot be so regarded. The charge is often brought

against municipal undertakings that they are of necessity parochial in character, and that in consequence, unless private trading is introduced, no large schemes, such as those of power distribution or comprehensive tramways schemes, can be worked.

This contention is based on two fallacious assumptions. In the first place, there is nothing to prevent local authorities combining for a large scheme. An example of such combination for lighting and power supply is seen in Manchester, where some eight or ten neighbouring authorities have agreed to take their supply of electrical energy from the city, while an even larger scheme for the tramways has been successfully negotiated, if one overlook the temporary secession of Salford.

The second fallacious assumption is that with trading companies the parochial difficulty will disappear. Those who have tried to arrange comprehensive schemes find that the difficulties of satisfying all requirements often prove insuperable, and the enterprise has to be dropped.

That there are inherent weaknesses in municipal management cannot, I think, be denied, and first among these I should place the liability to an entire change in the constitution of a committee, not on account of any inability to manage the undertaking, but purely from political reasons. Nothing can be worse for any undertaking than sudden and erratic changes of policy, and this want of continuity often produces disastrous results. A most noteworthy instance occurred recently in a metropolitan district in which an extensive and useful lighting and tramway scheme was projected, carried through its initial stages, and then, owing to a change in the constitution of the committee, suddenly dropped.

Next, the large size of most municipal committees tends greatly to hamper the work and to preclude the prompt action necessary in commercial undertakings, while the class of man preponderating on town councils tends each year to deteriorate, and men whose business is confined to the keeping of a small shop find themselves called upon to direct large undertakings requiring for their conduct a very Napoleon of commerce.

Again, there is a fatal tendency on the part of members of municipal committees to seek to shine as technical experts, often deriving their knowledge from some friend who has a smattering of the subject. These men insist upon interfering with their paid advisers, frequently marring their carefully thought-out plans.

Lastly, there is the danger, and it is a very serious one, of political considerations being allowed to influence the policy of municipal trading committees. More especially is this the case where any question of labour arises. Many members are in abject terror of the working class vote, and will go to almost any length to avoid losing it, with the result that the undertaking is severely handicapped.

Other charges, such as a tendency to corrupt practices, to favouritism of individuals, and so forth, are frequently brought against municipalities, but the tendency to these vices is inherent in human nature, and is quite as rife among directors of public companies as among members of municipal committees.

In spite of the drawbacks I have enumerated, excellent results, as we have seen, are produced under municipal management, and the reason for this is, I think, to be found in the class of man who has been attracted to the work. Municipal electrical engineers have shown themselves to be of quite a different stamp to the proverbial municipal official, and as a body they have displayed a spirit of independence, a keen enthusiasm for their work for its own sake, and an ardent desire to improve their undertakings in every possible direction. Central station practice owes much to municipal engineers, and one cannot but contrast the open manner in which they publish their results and experience with the policy of secrecy pursued by most of the officials of public companies who have fallen very far short of the ideal set up a good many years ago by Colonel Crompton, who was, I think, the first to urge upon electrical engineers the necessity for full publication in the interests of the industry at large, a doctrine which he was one of the first to put into practice.

Let us now leave this instance of the tendency to rush to extremes, and turn to another in which zeal has been allowed to outrun discretion and common sense.

During the past year much commotion has been caused by the action of certain gas and water companies in the matter of possible danger from electrolysis arising from the operations of traction systems.

The tendency mentioned has been evinced by both parties to the controversy. On the one hand, the gas and water companies, not satisfied with protecting their property, have sought to impose conditions which would make it commercially impossible for electrical engineers to carry out their work, while, on the other, electrical engineers have sought to repudiate responsibility altogether.

Let us look at the position impartially for a moment. Immense sums of money belonging to communities or to individual shareholders are invested in gas and water pipes laid underground, on the due maintenance of which depends the distribution of such a vital commodity as water and of such a universally employed agent as gas. There arises a new industry which necessitates the passing of electric currents through the soil in which these pipes are laid. It is known that under certain conditions these currents may damage the valuable property already in existence. Is it to be wondered at if those responsible for such property become alarmed and seek to insure themselves against loss if damage should occur? It is urged that if the promoters of electric traction comply with certain arbitrary regulations drawn up by the Board of Trade when the state of knowledge of the subject was far less complete than now, they would be exempt from all liability for damage caused, no matter how great this may be. Is this position consistent with common fairness? The gas and water companies have, with the sanction of Parliament, expended their money in order to meet public wants. Is it just that another company, which no less, but not more, than they, serves the public, should be allowed to conduct its operations in such a manner as to destroy their property? All parties should be granted the free use of the soil, but no one of them should be allowed to damage any other.

Surely, the only reasonable position is that the traction companies should be allowed to carry out their work in the manner sanctioned by the Board of Trade, but if damage can be proved to have been done by them, then they should bear the cost. If the traction companies have the confidence in the Board of Trade regulations which they profess to have, they surely cannot object to this because they will do no damage. On the other hand, if they do the damage, they ought to pay for it.

It is objected that many bogus claims for ordinary corrosion will be made on the electrical companies; this may be so, but, after all, the onus of proof of damage lies upon the gas and water companies, and the electrical engineering profession has not hitherto proved itself lacking in either ingenuity or ability, and may safely be relied upon to take care of itself. At all events such a consideration ought not to affect the broad question.

In this controversy the disastrous effect upon electric traction generally that would arise from a wholesale destruction of gas and water pipes, if such destruction should take place, seems to have been lost sight of, and I venture to think that those who point out the danger and enforce attention being paid to it now, are far greater benefactors to the profession than those who vociferate that there is no danger, and urge on traction companies to what might be ultimate ruin. There is no doubt that if the danger is recognised now, it can very well be avoided, for a much lower limit of drop of potential than that allowed by the Board of Trade can easily be worked to.

The second of our failings to which I have alluded is a want of foresight. A striking instance of this is the recent extensive promotion of Bills for the establishment of companies to generate electrical energy and distribute it over large districts. I do not wish for the moment to say one word upon the merits of these schemes. No doubt there are circumstances under which they may advantageously be undertaken, while, in other instances, it is difficult to see any justification for them. In any case, however, it is certain that they will require for their carrying out enormous quantities of plant of very large calibre. This demand is suddenly sprung upon our manufacturing firms; can we expect they will be ready to undertake the work? Surely the better plan would have been to have provided the capital first to extend existing companies, or even establish new ones for making the plant, and then to have promoted the power companies to purchase this plant.

Looking at the subject from a commercial point of view, there is, after all, but little advantage to the electrical industry as a whole in extending the use of electrical appliances if the manufacturers cannot share in the development. I greatly fear that the course adopted will result in the orders going abroad through the unfortunate want of foresight in thus putting the cart before the horse, the labour and enterprise expended thus by the promoters of the schemes availing only to increase the prosperity of our commercial rivals.

I might adduce many examples of want of foresight, but I will only allude to one other which has particularly struck me, probably on account of my long connection with central station work.

I refer to the way in which central stations are so often designed. In the early days of public supply it was not surprising that the demand should be under-estimated, and stations be put down on a totally inadequate scale, but now, in the light of accumulated experience, it is astonishing to see the initial instalment arranged for apparently without any regard to future increase, or if such increase be allowed for at all, it is of extremely limited extent.

Over and over again one sees designs such that it is physically impossible for the station to grow, and within a few years an entirely new station will have to be provided.

Only a few months since I read a description of a station concerning which it was naïvely remarked that the first instalment, in which a capacity of 1,000 H.P. was allowed for, would be self-contained and independent of further extensions later on, as though this were a merit of the design; and this in face of the efforts that are being made to centralise supply, even at the expense of costly long-distance mains. The two self-contained stations might almost as well have been a couple of miles apart as far as cost of management is concerned, while there would have been the benefit of such advantage as might arise from cheapening the distribution. In the same station the entrance to the repair shop was through the battery room—more want of foresight.

In concluding this address, time will only admit of my touching very briefly on one or two of the problems most likely to occupy our attention in the near future.

One matter which was mooted in the very early days of the electrical industry has come into great prominence in this country during the last two years, namely, the supply of electrical energy over large areas including small and scattered towns and villages. It does not appear, however, as though the method by which this is to be accomplished has received the consideration it deserves. In place of the problem being gone into thoroughly, it seems to have been assumed that a few enormous generating stations supplying, in some cases, to distances of 20 miles, must be the right thing, and there has been vague talk in which coal, gas engines, gas producers, recovery plant, revision of Board of Trade regulations, and so forth, have figured obscurely.

These hazy ideas, eked out with violent vituperation against everyone venturing to offer opposition, have given the impression that the difficulties have all been solved, and that it only remains to carry out the work. No explanation has been vouchsafed as to how the superposition of a number of similar demands, each with a low

load factor, is going to give as a resultant an improved load factor, or why a number of inherently unprofitable towns, when connected together by mains, the interest charges on which represent a large proportion of the total probable revenue, will be converted into a goldmine by the use of the magic words "supply in bulk."

Granted that gas engine driving with producer gas, in conjunction with recovery plant, gives the cheapest production of electrical energy, what evidence have we that such engines will enable alternators to be run in parallel satisfactorily under working conditions, and it must be borne in mind long-distance transmission must almost of necessity be by alternating currents. Recovery plant, no doubt, gives excellent results on a 100 per cent. load factor, but its successful working requires nice adjustments among all its parts, and its capital cost is high. What will be the effect of the sudden fluctuations of demand incidental to a central station, and how will the question of cost be affected when the interest charges have to be earned in an actual station with a load factor very much below 100 per cent? Again, is it remembered that in order to get the steam necessary for the recovery plant at a low cost, about one-fourth of the generating plant must be run by non-condensing engines, and this proportion must be preserved at all loads?

I do not say that these difficulties cannot be surmounted; I think they can, but I do say that we have heard little of the way in which they are to be met, and that meanwhile great mischief is wrought to less ambitious schemes by the utopian pictures which have been presented to the public of power supplied to consumers at prices no greater than the actual cost of generation, the cost of distribution and other essential charges being left out.

That gas engines driven with producer gas will in the future supplant steam in electrical generating stations there can be very little doubt, but their use will not be confined to stations of abnormal size, for their inherent advantages are very great. The consumption of fuel is but little more than half that of steam-driven plant, and the cleanliness and compactness of the system, coupled with the reduction of radiation and stand-by losses, render possible great strides in the direction of cheapening electrical energy even in very small stations.

There is one method of supplying small towns and villages which has not, I think, been put forward, but which might prove a cheap and easy solution of giving to them the advantages of electrical energy.

There are few towns so small as not to have a gasworks. Why should not the gas company establish producer plant and sell the gas to a locally formed electrical company, or to the local authority to use for driving electric generators? I should deprecate the gas company undertaking the electrical portion of the business themselves, partly because their staff would not have the necessary experience, partly because they would be tempted to stifle the electrical work. On the other hand, if the course I suggest were taken, each portion of the work would be looked after by those most competent to deal with it, and it would be to the interest of both parties to make the electrical undertaking succeed, for the gas company could make as great a rate of profit on the producer gas as on the ordinary lighting gas, while still enabling the electrical company to produce cheaply.

In considering this matter, it must not be forgotten that the preparation of producer gas for gas engines is by no means a simple matter, and if to this be added an ammonia recovery plant, a considerable amount of skill is required on the part of those looking after the manufacture. This skill is available in gasworks, and for this reason it would pay to put down recovery plant for producers working on a much smaller scale if the operations are carried on in connection with such works than if the plant were isolated.

This extension of the gas company's make would not be at the expense of their existing business, for it is a matter of experience that the introduction of electric light sets a higher standard of illumination, and actually increases the demand for gas for ordinary purposes, hence the introduction of the electric supply would be a clear gain to the gas company.

Gas engineers who are not wilfully blind to events must recognise that the public likes electric light and power if it can get them at a reasonable cost. It would be far wiser for them to accept the inevitable, and by joining hands with those they now look upon as enemies participate in this new outlet for their enterprise. Electrical engineers on their part would do well to recognise that gas engineers can help them, and to invoke their assistance in the application of gas for the production of electrical energy.

Perhaps the most important question of all at the present time is what has been so infelicitously called the "electrification of railways." That is to say, the application of electrical energy to the propulsion of ordinary railway trains over long distances.

Electric tramways have now become firmly established in this country, and there can be little doubt they will shortly become practically universal. The horse as a rival was easily beaten; the steam locomotive is one more difficult to displace, but the problem is already being vigorously attacked, and it looks as though for underground railways the battle is already won. The invasion will not, however, stop here, and already the application of electric traction to the main lines of railway is receiving serious consideration. What the result will be is by no means certain, but the present tendency to higher speeds is wholly in favour of electric traction. Though there is unquestionably much yet to be worked out as regards details, the future is distinctly promising.

This problem is in reality closely allied to the one to which I have already referred, namely, the supply of large areas of country, and the satisfactory solution of one problem will go far to help that of the other. Much depends upon the question of the pressure of supply to the motors on the trains, and on whether direct or alternating currents will be the more satisfactory. These are matters that must be gone into closely in each individual case with full data, but that a solution will be found can hardly be doubted.

I am compelled to leave untouched many matters that I might well include, but I have already trespassed far upon your patience, and I will, therefore, conclude with the expression of a hope that the session before us may be full of profit and interest to our members, and that many of the matters which I have so briefly touched upon will be fully discussed, and ample consideration be given to widely differing views.

THE PRESENT POSITION OF THE CARBIDE OF CALCIUM INDUSTRY IN EUROPE.

We have more than once referred in our columns to the excessive capitalisation which has characterised the development of the calcium carbide and acetylene industry in Europe.

Works for carbide manufacture have been multiplied out of all proportion to the demand for this product. The majority of such works are now lying idle, or are devoting their power and plant to other purposes. France, Italy, and Switzerland could each, *alone* if required, supply the present European demand for calcium carbide; while in Norway, Sweden, Germany and Austria, plant for carbide production is to be found in excess of the local consumption.

The Societa Forni Elettrici, of Rome, cannot pay any dividend for the last financial year; the Aktien Gesellschaft Elektricitätswerke Wynau, with works at Langenthal, in Switzerland, is in liquidation; and the carbide factory at Lauffen, in Germany, is shut down, as the account for the last financial year showed a loss of £400. At Thusis the generating machinery is to be turned to aluminium manufacture; and at the Ruhr carbide works, wood pulp is now to be produced.

This position of affairs is chiefly due to the past policy of the large German electrical firms, which have promoted sub-companies for carbide manufacture, in order to obtain an outlet for electrical plant and machinery. The recent failure of Schuckert & Co., of Nuremberg, to pay the expected 10 per cent. dividend for the year 1900—1901, is chiefly due to this policy. In 1899—1900, the Nuremberg firm were engaged in erecting a large power-station at Jaice, in Bosnia, where 9,200 H.P. was to be developed from the River Pliva by hydraulic engineering works of an extensive character. The directors of the Leipzig Bank were induced to invest heavily in this undertaking, and Schuckert & Co. themselves provided a certain proportion of the invested capital. It was arranged that 8,000 H.P. of the 9,200 H.P. available at Jaice should be devoted to carbide manufacture, and, in addition to the generating machinery, the Nuremberg firm supplied the plant required for the carbide works. In April, 1900, the plant was ready for operation, but the fall in carbide values, which occurred last year, upset all the calculations of the promoters, and the Jaice carbide works have utterly failed to earn the expected dividends. Under these circumstances, when the Leipzig Bank failure occurred, the Schuckert Company were obliged to take up the shares in the Jaice undertaking, held by the bank, and the £210,000 which had been set apart for the dividend payment was used in settling the bank account. It is now reported that the Nuremberg Company has succeeded in disposing of the shares, but it is very questionable whether more than one-half their nominal value has been obtained for them. The original mistake was in the decision to devote such a large portion of the power available at Jaice to the manufacture of a product for which the demand is still very limited.

The German method of financing industrial undertakings offers many advantages, but it is not without disadvantages; and the recent experience of the Schuckert shareholders will no doubt render the technical directors of German firms more cautious in future, and less inclined for reckless speculation in the carbide industry.

THE DESTRUCTIVE AND LETHAL EFFECTS OF HIGH-PRESSURE* CURRENTS.†

By Dr. MARGARET A. CLEAVES.

(*Continued from page* 910.)

In the electrocution of criminals, high pressure currents varying from 1,300 to 2,000 volts, periodicity about 130, are commonly used. and an alternating current of 1,700 volts has traversed the tissues of the body (electrocution, Jaylor, 1893) without arresting the respiration even with an application of 50 seconds' duration, and second and third applications of the current were necessary in order to kill the condemned criminal. (This statement must not be construed as an implication that high pressure currents do not kill, as used in electrocution at the present time, but is an illustration of the fact that a high pressure current is not necessarily fatal. Other factors

* In every instance in which authorities quoted have used the word "tension" in relation to an electric current, the writer has substituted "pressure," in order that the terminology may be exact.

† *Handbook of the Medical Sciences. (U.S.A.)*

influence the result, as will be pointed out later on.) The case of Jaylor also illustrates the fact—brought out by the experiments of Prévost and Battelli—that when the pressure is high, even when the heart lies on the line which unites the two contacts—*i.e.*, within the conducting path—this organ may not be affected, and that the nervous centres, continuing to be fed, are able to resist the action of the current; nor was the current traversing the tissues sufficient, in this case, to produce inhibition of the nerve centres, with definite arrest of the respiration. For the accomplishment of that result it was necessary to make a second and even a third application.

In the case of McElwaine (second electrocution), in which the points of contact were the head and arms—the hands and forearms being immersed in jars of saline solution—the effects were even less pronounced, and a second application, with the contacts applied to the head and calf of the leg, was found necessary in order to kill him. As in the case of Jaylor, the respiration was not affected by the first application. On the other hand, an alternating current of very much lower pressure—as low as 95 or 96 volts—has proved fatal in man; while several fatalities (four in number) occurred in a German mill,* within a short space of time from an alternating current of 115 volts pressure.

In the death resulting from contact with an alternating current of from 95 to 96 volts, all the conditions of the conducting circuit were good (see No. 9 of the tabulated references to accidents from industrial currents). The subject, a workman in a potash and alcohol plant, was instantly killed by an alternating current of from 95 to 96 volts. He stood on an iron tank covered with soda lye—an excellent conductor—and his boots were wrapped with rags of twilled linen.† Here was the best of contact, for the saturation of the linen rags implied of necessity a similar condition of the leather of his boots, and no doubt the conductivity was increased by the presence of nails in his boots, as is common in working men, although it is not so stated. The contact lasted for from 4 to 5 minutes, and the man was a drunkard. In this case, while the pressure was low, the resistance, by reason of position, superficies, and nature of the contacts, was reduced to a minimum, and the current strength (or number of amperes) must necessarily have been high. In addition, the heart was in the conducting path, the duration of contact was prolonged, and the man was a drunkard. In this instance, then, everything favoured a large electric energy, *i.e.*, a pressure, while low, fully effective because of low resistance, and resulting in large amperage; while long contact and diminished vital resistance, by reason of intemperate habits, contributed to the fatal result.

While there does not seem to be any direct connection between the lethal effect and the number of joules, there must be some remote effect, for the greater the energy, the greater the chance of death. The conditions in the above instance favoured the maximum rate of expending energy, the destructive power of which must have been increased, however, by the prolonged contact (300 seconds). The experiments of Prévost and Battelli show that the fatal effects are due to the energy, and that the energy required for killing a given animal increases in proportion to its weight. In a 1 lb. guinea pig, 400 joules were necessary to arrest respiration; while in one weighing 10 ozs., but 250 joules were necessary.‡

From experiments upon animals, accidents from industrial currents, and the electrocution of criminals, it is evident that the lethal effect is due to a sudden discharge. If the same amount of energy in joules was passed through the body slowly, the effects might be quite different. For example, 400 joules, the lethal dose for a 1 lb. guinea-pig, might mean a pressure of 20 volts, a current strength of 20 amperes continued for one second of time, *i.e.*, $20 \times 20 \times 1$ volt-ampere seconds = 400 joules; or $20 \times 0{\cdot}1 \times 200$ volt-ampere seconds = 400 joules. The result would be very different in each instance. In the first, a sudden discharge of great power; in the second a gradual expenditure of energy, lasting for 200 seconds, and accomplishing the same amount of electric work, but not violent nor disruptive in its action, as in the former instance.

This detailed case, as well as experimental work and the electrocutions instanced, show that the pressure necessary under one set of conditions is not required under another, and that a lethal dose does not of necessity require a current of high pressure. Prévost and Battelli found that under good electrical conditions, a dog—contacts head and hind limbs—could be killed with a current of 10 volts pressure; while 80 volts were necessary, under the same conditions, when the contacts were made to the head and fore-legs. In the former instance, the heart lay in the conducting path, while in the latter it did not, and was not only reached indirectly—requiring more power—but, by reason of increased resistance, a greater pressure was required to secure the current necessary to the production of a lethal effect.

This experiment illustrates the influence of the position of the contacts, as does also the case of McElwaine (second electrocution), in whom the head and hands formed the points of contact. In this instance the contacts were good—*i.e.*, saline solution—and there was a large superficies; but, by reason of their position, they were objectionable for the purpose contemplated, in that the heart was not placed in the conducting path, and consequently death did not result until their position was changed.

It is clearly shown, therefore, by an analysis of the work of different experimenters as well as of the accidents from industrial currents, that lethal effects follow contact with pressures of widely varying E.M.F.

An accidental contact with a high-pressure line or terminal—or with any pressure for that matter—rarely involves the same set of conditions, and often the conditions existing are such as to render it ineffective as a high-pressure current. Favourable conditions are obtained only (1) in experimental work, and (2) in electrocutions. It is not then a matter of pressure alone, for death results from currents of low pressure as well as from those of high pressure, and the latter are oftentimes ineffective, while a fatal result may follow contact with a low-pressure current.

Cases 3 and 10 (see tabulated references) illustrate the inefficacy of a high-pressure current with poor contacts; while No. 9 is a striking example of the efficacy of a low-pressure current with the best position as well as nature of the contacts; and it is not only a question of diminished electrical resistance, but of vital resistance (see Case 9) as well.

There can be no doubt that vital resistance must be counted as one of the conditions governing the action of a lethal dose. Kratter, in his experiments, found that a short exposure to an alternating current of 1,500 volts did not always prove fatal to rabbits and guinea-pigs, while others succumbed. With all the conditions of the conducting circuit absolutely the same, and with animals of the same species, age, and weight, this would indicate to the writer a difference in vital resistance—a factor which cannot be lost sight of in the administration of a lethal dose of electricity any more than in its therapeutic administration.

Cunningham, in his experiments, established the fact that anything acting to depress the vital forces increases susceptibility to the current. For example, after the cervical cord in an anæstbetised dog had been exposed and divided, it was found that a very brief passage of a current of 0·25 ampere caused the heart to stop immediately, although previously one of 0·65 ampere had been readily withstood. Whatever serves to depress the general condition increases the susceptibility even to weak currents.

From the action of a low-pressure current, when the effect is upon the heart (*i.e.*, causes fibrillar contraction), it is seen that such animal species as rats, frogs, and turtles recover spontaneously, whereas in the higher order of mammals, as well as man, death is absolute; but that from currents of a higher pressure death results in the former with a lower pressure and shorter contact than in the latter. This is when currents of high pressure act by reason of position and nature of contact as such.

The spontaneous recovery of such animals as rats, frogs and turtles depends upon the phenomena connected with the heart. The action of a low-pressure current is more severe and more lasting as the animal kingdom is ascended. The cold-blooded animals recover from the action of the current on the heart, while the warmer-blooded animals succumb. The heart is paralized in ventricular tremulations in all animals, and the phenomenon produced varies in intensity according to the genus of the animal. Prévost and Battelli used four genera of warm-blooded animals:—

1. Dogs, in which the characteristic action in the heart (ventricular tremulations) is well defined.

2. Guinea pigs—adults—in which the tremulations were most often, but not always well defined.

3. Rabbits, in which the tremulations are oftenest transitory, but in some cases well defined.

4. Rats, in which the tremulations last only during the electrisation of the heart. When this ceases the tremulations disappear and the ventricles resume their beat.*

These observations are in accord with the well-known physiological fact that while the hearts of the higher mammals very rarely recover spontaneously from a condition of fibrillar contraction, the hearts of those lower in the animal kingdom and of cold-blooded animals do; that in them a lethal effect must be produced by asphyxia, and necessitates the use of a current of higher pressure.

Results of Experimental Work, Physiological.—There is a wonderful similarity of result in retrospect of the work of different physiologists made within the past 11 years to determine the mechanism of death, although the earlier investigators did not carry their experiments to the definite conclusions of the later ones, and in some instances failed to appreciate and interpret correctly the phenomena observed. By far the most important experiments, and the only ones to which reference will be made—others having a purely historical interest—are those of (1) D'Arsonval, 1887; (2) Edward Tatum, Physiological Laboratory of the University of Pennsylvania, 1890; (3) Houston and Kennelly, Private Laboratory, Philadelphia, Pa., 1894 (undertaken not to determine the mechanism of death, but whether death did occur as the result of pressures similar to those used in electrocutions in which contacts were good, in order to refute the idea that in electrocution the current did not kill, and that the autopsy did); (4) Bokenham and Jones, Laboratory of the Royal College of Physicians and Surgeons, London, 1895; (5) A. M. Bleile, Physiological Laboratory, Ohio State University, 1895; (6) Kratter, 1895; (7) Oliver and Bolam, 1897; (8) Prévost and Battelli, Physiological Laboratory, University of Geneva, Switzerland, 1899; (9) R. H. Cunningham, Physiological Laboratory, Columbia University, 1899.

As a result of the experiments upon animals, of a study of accidents from industrial currents and from atmospheric electricity, and also of electrocutions, the generalisation is obvious that death due to an expenditure of electrical energy within the tissues occurs in two ways:—(1) By mechanical lesions of vital structures, or (2) by arrest of organic functions essential to life—*i.e.*, by arrest of respiration, heart's action, or nutritive exchange.

Death occurs, as a rule, in the first way, from lightning stroke, and there is an actual mechanical disintegration of vital structures. This is, however, not always the case. The deaths from lightning in this country are happily very few, being estimated at only about one per million of the population per annum. Oftentimes no trace

* Battelli, Frederic C.: "The Mechanism of Death by Electric Currents in Man."

† Kolben: *Elek. Zeit*, February 15th, 1900.

‡ Prévost and Battelli: "The Mechanism of Death by Electric Currents in Man."

* Battelli, Frederic C.

of injury can be seen upon the subject of the accident, but in other cases various marks are found upon the body, or the clothing will be torn or scorched; and it not infrequently happens that the boots are torn off the feet, and nails driven out of the soles of the boots. The following case illustrates, in a striking manner, the disruptive action of this tremendous energy.

The accident occurred in Guildford, England, August 25th, 1897, and the inquest revealed that the man was found, one-half hour after a single flash of lightning and a clap of thunder, lying on his face. Around him, within a radius of several yards, were his clothes and boots, which had been torn and scattered about in an extraordinary manner. The lightning appeared to have struck him on the right side of the head, tearing his cap to pieces and burning his hair off. It then passed inside his collar, down the front of his body and both legs into his boots, which were torn to pieces, and then it passed into the ground, making a hole about 18 in. in circumference and 3 in. deep. His collar was torn to pieces, the front of his shirt was rent into ribbons, the jacket and undervest were literally torn to shreds, and the knickerbockers he was wearing were stripped from him and scattered on the ground. His stockings and gaiters were similarly torn to pieces, and on the boots the lightning had a remarkable effect. They were burst open, some of the brass eyelet holes were torn out, nails were forced out, and the soles were torn out. The skin had been torn off the chest, and the right leg was torn and blackened; blood was issuing from the mouth and right ear.*

In view of the fact that the current strength of a particular stroke of lightning, from the data presented, has been estimated at at least hundreds, if not thousands, of amperes, it is not difficult to account for the phenomena described.†

There is no doubt that a lightning stroke acts sometimes as a high pressure current—*i.e.*, it causes an inhibition of the respiratory centre and syncope, and it is in such cases that recovery follows either spontaneously or from artificial respiration. That death occurs sometimes in the first way from industrial currents is unquestionable, and the post-mortem findings in some of the electrocutions point to an actual mechanical disintegration of the vascular structures; at least, such seems to have been the case in the twenty-fourth electrocution (Hampton), witnessed and reported by Drs. A. E. Kennelly and Augustin Goelet.‡ In this case, upon post-mortem examination, it was observed that the blood was driven from the peripheral vessels into the organs and tissues of the chest and head, and there was actual rupture of the over-distended vessels. Examination of the brain demonstrated the presence of a quantity of dark blood, due to rupture of the blood-vessels. It was estimated that at least two quarts escaped from the scalp and cranium in removing the brain. Upon the removal of the dura mater, the vessels on the surface were seen to be distended, while in many places there were evidences of rupture. The same condition existed in the interior of the brain, and coagulated blood was found at the base of this organ.

As to the actual mechanism of death occurring in the second way, for a long time there was no uniformity of opinion among physiologists. Happily, more solid ground seems now to have been reached.

(To be continued.)

* The *Electrical Engineer*, N.Y., October 21st, 1897.

† Wurtz, Alex. J.: "The Current Strength of a Lightning Stroke." The *Electrical Engineer*, N.Y., October 27th, 1898.

‡ Kennelly and Goelet: "Does Execution by Electricity Produce Instantaneous, Painless, and Absolute Death?" *Electrical World*, Vol. xxv., p. 195.

MUNICIPAL COMPETITION.

The time has arrived when the electrical trades must take prompt and energetic action, if they are to save their business from the ruinous competition threatened by the municipalities. The preliminary notices of the Bills intended to be promoted in the next session of Parliament bristle with attacks on the trading community connected with the electric industry.

The London County Council lead the way with Bills, in the first place to enable the Metropolitan Boroughs to absorb all the existing undertakings established by private enterprise within the area of the County of London; and in the second place, to empower these authorities to expend money upon the wiring and fitting and supplying with wires, fittings and apparatus, the premises of any of their consumers, or prospective consumers, of electric energy, and to enter into and to carry into effect, agreements and arrangements with respect thereto, and to make such charges therefor, whether directly or otherwise, as they may think fit, and to borrow money for the purpose.

Hitherto some protection has been enjoyed by the trades, through the practice of the Local Government Board of refusing assent to loans for free wiring, but this course can no longer be relied upon, and if the projected Bills are passed, no such action could stand in the way.

Leading towns in the provinces are asking for extensive trading powers, and it must not be forgotten that a powerful society exists for promoting their interests in Parliament. The Association of Municipal Corporations must be met by a strong combination of the electrical trades, with a branch in every town where their interests are threatened, to counteract the efforts of the organisation supporting municipal trading.

Such an Association would exercise an important influence upon the local councils, as well as in opposing pernicious schemes in Parliament.

It was hoped that the Special Committee of the Institution of Electrical Engineers would have come to the rescue of the trade, but apparently they take no action, and so far as municipal trading is concerned, opinions and interests within the Institution are too much divided for that body to effectively lead in the matter.

The London Electrical Contractors' Association's meeting last week was full of interest. Mr. Gillard pointed out at the meeting the case of a Borough Council under-quoting to such an extent that a large firm of ratepayers had to abandon their contracting business; and he drew no fanciful picture of the effect upon the legitimate trader of such competition by a local authority, using public money to deprive their own ratepayers of their livelihood.

Drastic measures are necessary to put a stop to the mad career of the Socialist party in the municipalities, and the limitation of the authorities to the legitimate business of local management. There must be a united attack upon the whole principle of municipal trading, and there is no reason why the electric industry should be left to fight the question alone, for many other trades may be engulfed in the same system.

Among the notices for next session, the Wigan Corporation ask for powers "to prepare, sell, and supply humanised milk and other food for infants," by no means a dispensation of the milk of human kindness to the ordinary purveyors.

In the various Bills of municipalities power is sought for the manufacture and supply of motors, engines, wires, fuses, fittings, switches, lamps, dynamos, and other apparatus incidental to the supply or consumption of electricity, and for the construction, laying down, inspecting, and testing of meters; and in the instance of Birkenhead, the Corporation apply for power, not only to manufacture and supply meters, but *to prescribe their form and nature.*

Without careful examination, many of these applications for powers to construct and sell electrical fittings and apparatus might be easily overlooked, as they are imported into Tramway, Water, Gas, and General Powers Bills, requiring vigilance on the part of any union of the trades formed for their protection against the competition of municipalities.

Some such association as the London Electrical Contractors' Association, or a combination of the Chambers of Commerce might well take the initiative of calling the trades together to consider the position as one of urgency, and to form an executive committee for opposing the Bills.

Petitions against the Bills should be promoted by the traders affected in all the towns where the authorities are seeking powers detrimental to the local traders. Eminent Parliamentary counsel should be engaged to represent the petitioners, and efforts made to oppose the second reading of the Bills and their passing through committee without the elimination of the objectionable clauses.

Many of the Bills contain financial proposals which require careful examination, such as powers for the issue of promissory notes and bills for borrowed money, and the postponement of payments to any sinking fund formed for the discharge of moneys borrowed or raised in relation to electricity undertakings. There is no limit to the lengths the Socialists will go, unless curbed by Parliament. The opponents of municipal trading must be united on a common ground. While there are some who are opposed entirely to the system, root and branch, others would be content to leave it where it is, but to prevent any further extension, and another section would even sanction municipal trading providing that no profit was made; but this view will commend itself neither to the Socialist nor the trader, for the *raison d'être* in the

one case is profit in aid of the rates, and in the other it simply means the ruin of the trader.

Fancy the delicate manipulation of a business so that it should result in neither profit nor loss! The stipulation that Shylock might cut the pound of flesh, provided that no drop of blood was shed, was nothing to it.

We appeal to the whole electrical trade to take up this matter seriously, and at once. Our columns are open to promote the movement, which we feel to be of supreme importance.

It is emphatically a case of the thin end of the wedge, which, if driven home, means ruin.

MAGNETIC TESTING OF IRON IN BULK.

Some years ago we recalled the suggestion of a learned professor that the magnetic quality of iron in bulk might be ascertained by placing a couple of coils on the surface, using one as a magnetising and the other as a search coil. It was shown at the time that this would not give any useful results, as the magnetic path would be partly air and partly iron. Dr. C. V. Drysdale has done what so many have failed to achieve, he realised a notion of how a thing might be done and immediately proceeded to put it into practice. The simplicity of the device he described last week to the Institution of Electrical Engineers will do much to create a desire for numerical results regarding all castings and forgings whose magnetic qualities are of importance, but which are seldom tested owing to the mystery which has heretofore surrounded the laboratory methods of obtaining the B-H curve, or even of taking single values to find the permeability at a known induction value.

The apparatus is simplicity itself, consisting essentially of a small bobbin or spool with two coils wound thereon—one to serve as the magnetising coil and the other as a search coil. An annular hole is drilled into the mass to be tested, and this spool is slipped into the space so formed. The induction is obtained from a knowledge of the magnetising current, and the induced throw on reversing gives the induction in the pin or test piece in the centre of the coil. All other particulars are obtained and furnished by the maker of the apparatus, which in itself contains the requisite galvanometers, reversing key, and variable resistances.

This instrument was received with a chorus of praise, criticism being directed only at the accuracy attainable with it. Mr. Evershed compared it with the testing of a piece of cheese, but hinted that the joints between the spool handle and the sides of the drilled hole, and the air-gap between the pin and the coils, would cause the results to be less than perfectly accurate. This, he thought, was shown by the shape of, and values in, the curves which Dr. Drysdale had obtained. Thus the values given were extremely low for the forces employed; but anything that "shunted" the secohm-meter, "a useful instrument for puzzling students," should find favour. The secohm-meter is not such a terrible instrument as its misleading name would induce people to believe; but this by the way. When taking cyclic curves the method must be one which got rid of the time change, or the ordinary step-by-step up the curve would give too low results, as each step was started too high up on the curve. Mr. Glazebrook also thought the effect of joints had not been got over, and that very small differences in these produced great effects. He also referred to the air-gap round the pin, but even admitting something in this, he knew that such an instrument was wanted, and congratulated the author upon arranging to get the search coil into a mass of metal; however, he did not think that $\frac{5}{8}$ of an inch into the interior would really give the information that was desired.

Mr. Esson thought the value of the apparatus lay in the aid it gave towards comparing one casting with another, although he could foresee that some practical difficulties might be found in drilling the hole. The testing of castings in bulk was an idea that must be given up, as there was no guarantee that a sample would truly represent the bulk, but there was more likelihood that a casting as a whole would come up to the part tested in Dr. Drysdale's apparatus than if a separate test piece had to be cut out.

Mr. Mordey reminded the meeting that in May, 1898, he had asked Prof. Ewing to give the profession an instrument that would enable tests to be made on large blocks of iron. "We want an instrument to test iron before we do any tooling on it" (*Jour. Inst. Elec. Eng.*, Vol. xxvii., p. 537). This instrument destroyed the last line of defence of the electrical designer. The tooling of the pin might possibly alter the physical state of the iron tested and create misleading results. Care would have to be taken to see that the size of the drill remained unaltered. Dr. Walmsley mentioned that the split cone on the handle portion of the search coil was designed to get a good grip on the test pin. Mr. S. F. Walker urged the importance of ascertaining that the E.M.F. of the testing battery was constant if the magnetising current was not actually measured, while Mr. Joyce believed the curves at least showed the effect of the air-gap to be constant and of a permanent nature, so that it could be allowed for. Prof. Perry desired to know why the pin should not be removed and tested by the yoke and bar method.

Dr. Drysdale replied that there were differences at low induction densities, but if there was an air-gap it was a remarkably constant one. The drilling of the hole was the critical matter, but this was a smaller concern than tooling a casting which might have to be rejected finally. There was, he thought, little doubt that the instrument could be made to give some indications as to quality in six or seven cases out of eight, and with this opinion most of those present seemed to agree.

SPECIAL STEEL.

During the past year there have come into some considerable prominence special methods of treating and alloying tool steel, for which great things have been claimed. One of these is known as the Taylor-White process of the Bethlehem steel works, but substantially, we believe, all these special steels are alike in their composition and in their treatment. They are air hardened. Hitherto the air hardening steels were never to be heated above a cherry red. Mr. Day, in a paper read before the Franklin Institute, gives this cherry red temperature as 1,550° to 1,600° F. The composition of such steel would include 1 per cent. of chromium and 1 per cent. of some other member of the same group, tungsten being found to give the best results. But even better results were found with 1 per cent. of chromium and 4 per cent. of tungsten, and for hard metals, such as the skin of cast-iron, 3 per cent. of chromium and 6 of tungsten or even more. Carbon from 85 to 200 points seemed to be equally good, the variation apparently mattering little. These new special steels are hardened by heating up to 2,000° F., and rapidly cooling off in melted lead, then slowly in air or in lime. The temperature must never rise. The surface is deteriorated to a depth of $\frac{1}{16}$ in. This should be ground off. The Taylor-White steel is by no means alone in the market. More than one firm in Sheffield has successfully produced these special steels, and we have tried them up to speeds of as high as 200 ft. per minute on cast-iron. Not until this cutting velocity was reached did the tool fail by melting. Speeds of 100 ft. on cast-iron can regularly be run with a cut of $\frac{1}{2}$ in. and a feed of $\frac{1}{16}$ in., and on mild steel great shavings are cut which turn blue at once with heat. There now seems no doubt that these special alloys have every prospect of establishing themselves. They will quite modify the construction of machine tools, rendering it necessary to increase the power of the driving belts by increased speed of the countershaft or otherwise, and to strengthen machines generally. Reductions of time on jobs may be effected to the extent of 75 per cent. These new steels, in fact, bid fair greatly to reduce the cost of machine work, and we think that English engineers should be prepared to adopt them, as they must result in very considerably shop economies. It is also likely that they will bring about more rapidly what was already coming slowly to the fore, namely, the finishing of surfaces by means of the grinding machine. Hitherto, grinding has been looked upon as belonging properly to particularly accurate work, such as the hardened spindles of a lathe or a drilling machine, or

the bearings of a high speed engine. It is possible that when by means of special steels, mild steel can be turned at a speed of even 150 ft. per minute, as we have seen it done in the Loëwe shops in Berlin, the lathe will become little else than a heavy cutting roughing-out tool of no very special accuracy, and work will be finished on heavy grinding machines to an accuracy impossible with the lathe. Old but powerful lathes, useless as to accuracy of finished work, might, in many cases, be retained if they would stand up to the heavy rough cuts demanded for the new steels, and the money set aside for their renewal could perhaps better be spent on powerful grinding machines to follow the roughing lathe. These special steels are quite soft and can easily be filed. Yet they stand up to steel and hard cast-iron and retain their cutting edges in a most extraordinary manner, and we venture to say that those who first grapple with their use will be in a very strong position to compete in manufacturing.

CURRENT SPECIFICATIONS.

LXXXIII.—PONTYPRIDD ELECTRIC LIGHTING.

Summary.

Extent of Contract.—Under various sections, supply and erection of electric lighting plant:—Section B.—Steam dynamo and balancer. Section C.—Switchboard. Section G.—Arc lamps.

System Proposed.—Low pressure direct current, 500 volts. Lighting network to be three-wire, with 250 volts between middle wire and outer; for traction work ordinary 500-volt circuit, and for street arc lighting open type arcs if selected to be run five in series across 250-volt mains, or enclosed lamps if preferred five in series across 500-volt mains.

Number of Steam Dynamos.—Three; two of 300 KW. output, and one of 150 KW. output.

Permissible Speed.—200 revolutions per minute for the 300-KW. sets, and 300 revolutions per minute for the 250-KW. set.

Type.—To be of compound or triple-expansion vertical slow-speed type, all motions being enclosed in dust-proof chambers.

Overload.—To be suitable for use on traction load with its fluctuating requirements if necessary, and to be capable of working continuously at 15 per cent. overload, or short periods at 25 per cent. overload.

Conditions of Working.—Steam pressure approximately 195 lbs. per sq. in., steam superheated 150° F. Engines to work either condensing with 24 in. vacuum or exhausting to atmosphere.

Range of Governing.—To be capable of hand adjustment whilst running to extent of 5 per cent. The momentary variation when whole load is thrown off is not to exceed 5 per cent., or the permanent variation 3 per cent.

Emergency Governor.—To be fitted independently of above.

Dynamo Outputs.—Large sets, 300 KW. as normal load at 500 volts; small set, 150 KW. under similar conditions. To be compound wound, with means of adjustment at constant speed between 450 volts and 500 volts. To be capable of giving 25 per cent. for short periods, or 50 per cent. momentarily above normal loads without injury.

Temperature Rise.—Not to exceed 70° F. above surrounding atmosphere, measured by means of thermometers after 6 hours' full load run, or after 18 hours' run at varying load. After one hour's run at 50 per cent. overload the temperature must not exceed 100° F. above atmosphere.

Guaranteed Steam Consumptions.—To be stated by tenderers under varying loads and conditions of working.

Motor Balancer.—To consist of five machines directly coupled together. The centre one to be a motor wound for 500 volts, of 120-KW. input, each of the others being 30-KW. dynamos wound for 250 volts. Either pair of dynamos to be suitable for connecting to network if required.

Specified Overload.—Any of the dynamos to be able to develop 25 per cent. overload without injury continuously. Speed of combination not to exceed 1,000 revolutions per minute.

Switchboard.—To be arranged for lighting, traction and street lighting load, and to consist of 17 panels of polished marble, having mounted upon them the specified instruments and switch gear.

Type of Ammeters and Voltmeters.—To be of Weston, White, or other approved pattern, fitted where specified with illuminated dials.

Arc Lamps.—To be 40 in all, to be mounted on carriers provided under this contract to existing tramway poles.

Type of Lamp.—To be either single carbon open-type lamps, burning 16 hours without recarboning, or enclosed type arranged to burn without attention for 75 hours. The open type lamps, if selected, to burn five in series across 250-volt circuit, or the enclosed type lamps, if decided on, five in series across 500-volt mains.

Specified Date of Completion.—Steam dynamos and switchboard within eight months of date of order, arc lamps within nine months from same date.

Penalty for Late Completion.—5 per cent. of contract price per week.

Terms of Payment.—80 per cent. on monthly certificates of engineer of value of work executed and plant delivered on site, 10 per cent. within one month of plant being put into effective usage, 10 per cent. six months later.

Period of Maintenance.—12 months from date of completion.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages to be Paid to Workmen.—Acceptable.

Sureties.—Contractor must find two to be joined in a bond up to 25 per cent. of contract price.

Arbitration Proposals.—May be accepted.

Date for Receipt of Tenders.—December 14th, 1901.

This specification has been prepared by Mr. R. P. Wilson, the consulting engineer to the Urban District Council.

The technical requirements are in some respects interesting. The speed of the steam dynamos is specified not to exceed 200 revolutions per minute for the large sets, and 300 revolutions per minute for the small sets. These figures are hardly compatible with the term "slow speed" used in describing the engines. A curious stipulation in this connection is that for comparative purposes, one of the offers should be for dynamos running at 100 revolutions per minute for either output. This seems to us a perfectly unnecessary hardship for the tenderer; if he chooses speeds near the limits permitted by the specification, it is practically certain that the design will so materially differ from what the tenderer would offer for a 100-revolution machine (more than twice the size in one case), that the so-called comparison is practically worthless, while the cost to tenderer of preparing his offer is needlessly increased.

The tests seem to be unnecessarily elaborate, and in our opinion there are several items which might have been omitted or modified without interfering with the working efficiency of the system. For instance, the five-machine motor balancer, with the motor large enough to drive all four dynamos at the same time at 25 per cent. overload, necessitates a larger motor than usual experience deems to be necessary.

The general conditions are, on the whole, satisfactory; we note that the wages to be paid to workpeople are to be those in vogue in the district of *Aston Manor;* we presume this is a misprint for Pontypridd.

The penalty clause, with its *five per cent. per week penalty*, needs modifying, unless the purchasers are prepared for a reasonable period to grant a corresponding bonus for early completion, and this, we fear, is very unlikely.

Tenderers for the cable section must be careful to ask for a modification of the *ten years* free maintenance specified.

The arbitration clause is satisfactory and may be accepted without comment, being based on the agreement arrived at between the Municipal Electrical Association and the Electrical Plant Manufacturers' Association.

CONTRACTS WITH CONSUMERS.

As time goes on and competition between rival supply companies becomes more and more severe, it becomes necessary to define, with the greatest possible accuracy, the legal relationship of company and consumer. Anxiety to increase the number of consumers naturally tempts a company to offer terms which are much easier than those which they are entitled to offer by provisional order or special Act. "Free wiring," for instance, is constantly held out to the consumer as an inducement; but in order to make a free wiring contract profitable to the company, it is necessary for terms to be inserted in the contract which bind the consumer to take supply for a certain period, to pay a minimum charge, or to bind himself not to take current from any other source. Again, what is termed "municipal blackmail" sometimes influences very materially the relationship between a private supply company and a local authority as consumers of electricity for street lighting. Knowing that they are in a position to place obstacles in the way of a provisional order being granted to a private company, the local authority are able to dictate the terms upon which energy is to be supplied for public lighting. This obligation is sometimes imposed on the supply company by statutory contract, or by a clause in some agreement.

Certain recent cases throw much light upon the interpretation of these agreements with consumers. They serve to show that so long as the supply company keeps within the four corners of the statute under which they are entitled to supply electricity, their rights as against consumers will be strictly enforced by the Courts. The case of The Metropolitan Electric Supply Company *v.* Gender (Electrical Review, May 3rd, 1901; 17 T.L.R. 435), is an authority for saying that where a consumer agrees to take the whole of the electrical energy required for his premises from a particular company, an action will lie at any time during the currency of that period for an injunction to restrain him from obtaining his supply elsewhere. To use the words of Mr. Justice Buckley: "In such a case a contract is implied not to take energy from any one except the plaintiffs. Being a trade contract for supply, and not a contract for personal service, this can be enforced by injunction." This case is also of importance in that it is an authority for saying that the unfortunate accident which sometimes occur to break the continuity of supply do not constitute sufficient ground for the consumer giving a notice to terminate his contract for supply.

In the so-called "free wiring" contracts, to which allusion has

already been made, it is obvious that the expense of laying the wires must must in some way be met by periodical payments on the part of the consumer. In such a case, if the payment depends entirely upon the quantity of electricity consumed, and no minimum is fixed by the supply company, recoupment of the capital laid out in putting in private installations may be long deferred. The case of the London Electric Supply Corporation *v.* Priddis (18 T.L.R., 64; Electrical Review, November 22nd, 1901, p. 831) illustrates the interpretation which the Court will put upon a contract which is drawn up with a view to obviating this difficulty.

The case turned upon the meaning of a clause in an agreement between supply company and consumer. The supply company agreed, through the medium of the Free Wiring Company (who were parties to the agreement), that they would "in a proper manner, and in accordance with the regulations of the fire insurance companies, and free of cost to the consumer, furnish and fit up on the said premises the necessary wires and fittings for electric lighting. At the end of five years the consumer was to have the option of purchasing the installation at cost price plus 20 per cent. and less 1½ per cent. per annum, from the date of the installation for depreciation. The contract also contained the following provisions:—(1) The consumer shall until purchase, as aforesaid, pay quarterly to the supply company *for the use of the installation* ¾d. per B. of T. unit for every unit of electrical energy supplied to the said premises, the *minimum* payment in each year to be 1s. for each 8 c.p. lamp or its equivalent installed. "8. If the consumer or other occupier for the time being of the said premises shall cease to take a supply of electrical energy to the said premises from the supply company, or shall neglect or refuse to pay *for the use of the installation* as aforesaid, the supply company may at any time enter upon the said premises, and remove, and take away the installation, but if they shall do any damage to the premises by such removal, they shall make good, or cause to be made good, the same."

During one quarter, the defendant made no *use* of the installation in the sense that he took no current during that time. Upon this, the company sued him for the minimum charge which the agreement provided should be paid for the *use* of the installation.

The County Court judge construed the word *use*, to imply actual user of the current. The Divisional Court, however, reversed this decision. Channell, J., said (18 T.L.R., at p. 65):—"The meaning of the clause is that the minimum rent does not merely cover the actual use, but the right to use the current. The customer has to pay for the right to use the current, although he did not in fact use it." The case was then sent back to the County Court Judge for a new trial. Upon consideration of Clause 7 of the agreement (above set out), it is clear that the company had in view the possibility of their installation going out of use. The clause, which has all the appearance of having been drawn up with considerable art, provides for estimation of the minimum payment on a basis which depends not upon the amount of current, but upon the number of lamps used by the consumer. Had no such clause been inserted in the contract, the installation might have remained on the consumer's premises until doomsday, unless, indeed, the supply company had put in force the provisions of Clause 8 of the agreement. In entering into a contract with a local authority, the supply company should be careful to observe Sec. 174 of the Public Health Act, 1875, which provides that every contract made by an urban authority whereof the value or amount exceeds £50, "shall specify some pecuniary penalty to be fixed in case the terms of the contract are not duly performed." In the case of the British Insulated Wire Company *v.* Prescot Urban District Council [(1895) 2 Q.B., 463, 538], the plaintiffs and defendants had entered into a contract in writing, duly sealed by the defendants, whereby the plaintiffs agreed to efficiently light, by means of electricity, the streets within the defendants' district for a period of five years for the sum of £350 annually, to be paid quarterly. There was an arbitration clause in the agreement, but it contained no penalty clause. The plaintiffs duly supplied the electricity, and brought this action for the price. It was decided by the Court (Baron Pollock and Wright, J.), that the enactment was obligatory, and not directory only; so that the contract in question could not be enforced against the defendants.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this Journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

23,261. "Automatic switch for switching off an electric motor used for pumping purposes." M. G. Drake and Drake & Gorham, Ltd. November 18th.

23,300. "Improvements in electro-magnetic couplings." O. Imray. (J. L. Onken, Germany.) November 18th.

23,308. "Improvements in and relating to incandescent electric lamps." F. Fanta. November 18th.

23,309. "Improvements in or relating to trolley heads for tramways and the like." D. B. Foster. November 18th.

23,312. "Improvements in insulating gloves for use in electrical or chemical operations." G. Heyl-Dia. November 18th.

23,315. "Improvements in electric glow lamps." A. J. H. Gurney and A. S. Blundell. November 18th.

23,358. "Combination shade tilter cord grip and cord shortener for electric lamps." J. J. Williams. November 19th.

23,376. "Improvements in electric fuse boxes." The British Thomson-Houston Company, Limited. (T. V. Aller, United States.) November 19th. (Complete.)

23,377. "Improvements in electric fuse boxes." The British Thomson-Houston Company, Limited. (R. H. Read, United States.) November 19th. (Complete.)

23,378. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (R. Fleming, United States.) November 19th. (Complete.)

23,379. "Improvements in electric current transformers." The British Thomson-Houston Company, Limited. (W. S. Moody, United States.) November 19th. (Complete.)

23,380. "Improvements in electric fans." The British Thomson-Houston Company, Limited. (J. J. Wood, United States.) November 19th. (Complete.)

23,393. "Improvements in the equipment of electrically-propelled cars." Siemens Bros. & Co., Limited. (F. Lydall, Germany, November 19th.

23,399. "Improvements in the equipment of electrically-propelled cars." Siemens Bros. & Co., Limited. (F. Lydall, Germany.) November 19th.

23,400. "Improvements in the equipment of electrically-propelled cars." Siemens Bros. & Co., Limited. (F. Lydall, Germany.) November 19th.

23,401. "An improvement in controllers for electrically-propelled cars." Siemens Bros. & Co., Limited. (F. Lydall, Germany.) November 19th.

23,413. "Improvements in or relating to dynamo-electric machines." A. J. Boult. (C. M. J. (styled Claudius) Limb, France.) November 19th.

23,423. "Improvements in and relating to means for supporting and insulating the trolley wires of electric tramways on the overhead trolley wire system." W. C. Ullman and A. E. Barber. November 19th.

23,429. "Improved system of electrical propulsion for railway and other cars." W. P. Thompson, (G. J. Scott, W. S. Janney, and F. Le Bar, United States.) November 19th. (Complete.)

23,433. "Improvement connected with incandescent lampholders." E. Schulz. November 19th.

23,444. "Improvements in electric lighting, and in apparatus connected therewith." C. H. Woodward. November 19th.

23,446. "Improvements in automatic electric circuit breakers." H. J. Haddan. (The General Incandescent Arc Light Company, United States.) November 19th.

23,456. "Improvements in and relating to electrical resistances." H. A. Mavor and Mavor & Coulson, Limited. November 19th.

23,485. "Improvements in and relating to the working of electric or other tramway or railway points." W. J. Stewart. November 20th.

23,536. "Improvements in apparatus for treating patients with electrical lighting and heating rays." H. J. Dowsing. November 20th.

23,542. "Improvements in or connected with electric arc lamps." J. L. Davies. November 20th. (Complete.)

23,550. "An improved road contact stud for use in connection with closed conduit systems of electric traction." W. Griffiths and B. H. Bedell. November 20th.

23,581. "An improved clip for coupling severed wires in overhead wire systems of electric traction; applicable also as a coupling for use in connection with fittings appertaining to such systems; and as a section insulator." H. Brecknell, E. M. Munro, and H. I. Rogers. November 21st.

23,600. "Improvements in shunts for electrical measuring instruments." A. Eckstein and F. Panter. November 21st.

23,622. "An automatic device for cutting off the electric current from suspended or overhead conductors, in case of breakage or falling." H. E. Hunt. November 21st.

23,637. "Improvements in electro-magnetic couplings." O. Imray. (J. H. L. Onken, Germany.) November 21st.

23,659. "Improvements in hoisters for suspended electric lamps." O. Graetzer. November 21st.

23,668. "Improvements in street feeder boxes or disconnecting pillar boxes for electric traction, electric lighting, or electric power purposes." J. A. Fletcher and S. Fletcher. November 21st.

23,690. "Improvements in electrical switches." A. E. King. November 22nd.

23,703. "Improvements in and relating to pre-payment meters for the supply of electricity." J. Finlayson. November 22nd.

23,708. "Improvements in inter-communication telephones." M. Benswanger-Byng and F. G. Bell. November 22nd.

23,723. "Improvements in galvometers." The British Thomson-Houston Company, Limited, and F. Holden. November 22nd.

23,738. "Improvements in magnetiseable bodies for use in telegraphones." P. O. Pedersen. November 22nd.

23,755. "Improvements in microphones." R. Lucke. November 22nd. Complete.)

23,756. "An improvement in mechanical converters of electric current." L. Joseph. November 22nd. (Complete.)

23,768. "A detachable overhead covering for electric cars." A. Woods and W. H. Brown. November 23rd.

23,773. "Improvements in drums for holding electric cables." H. Sutcliffe. November 23rd.

23,804. "Improvements in electric motor systems." The British Thomson-Houston Company, Limited. (G. O. Baker, United States.) November 23rd. (Complete.)

23,805. "Improvements in electric circuit breakers." The British Thomson-Houston Company, Limited. (C. C. Badeau, United States.) November 23rd. (Complete.)

23,806. "Improvements in systems of electric motor control." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) November 23rd. (Complete.)

23,813. "Improvements in dynamometers or dynamometric transmission gear for revolving shafts." H. Muller. November 23rd.

23,838. "Improvements in or connected with telephone systems." I. H. Parsons and T. Sloper. November 23rd.

23,845. "Improvements in and relating to dynamo-electric machinery." H. A. Mavor and Mavor & Coulson, Ltd. November 23rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1900.

1,290. "Improvements in and connected with the reproduction of writing, printing, drawing, and the like by the Rontgen rays." G. Izambard. Dated January 20th, 1900. Röntgen ray apparatus; negatives, producing by other means than photography; sensitized plates, &c., copying documents, &c. Relates chiefly to the production of screens or negatives from which photographic prints are obtained by means of the Röntgen rays.

1,309. "Improvements in the manufacture of compound metal tubes suitable for gas and electrical conductors." J. Earle. Dated January 20th, 1900. Compound or double tubes, suitable for gas and electrical conductors, in which a smaller and eccentric inner tube is surrounded by a larger tube, are made from a single tube or piece of metal by drawing through dies. The single tube is first bent into curved portions which are afterwards brought together and united.